Materials Engineering in Product Design & Manufacture

Materials & Methods

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June 1955

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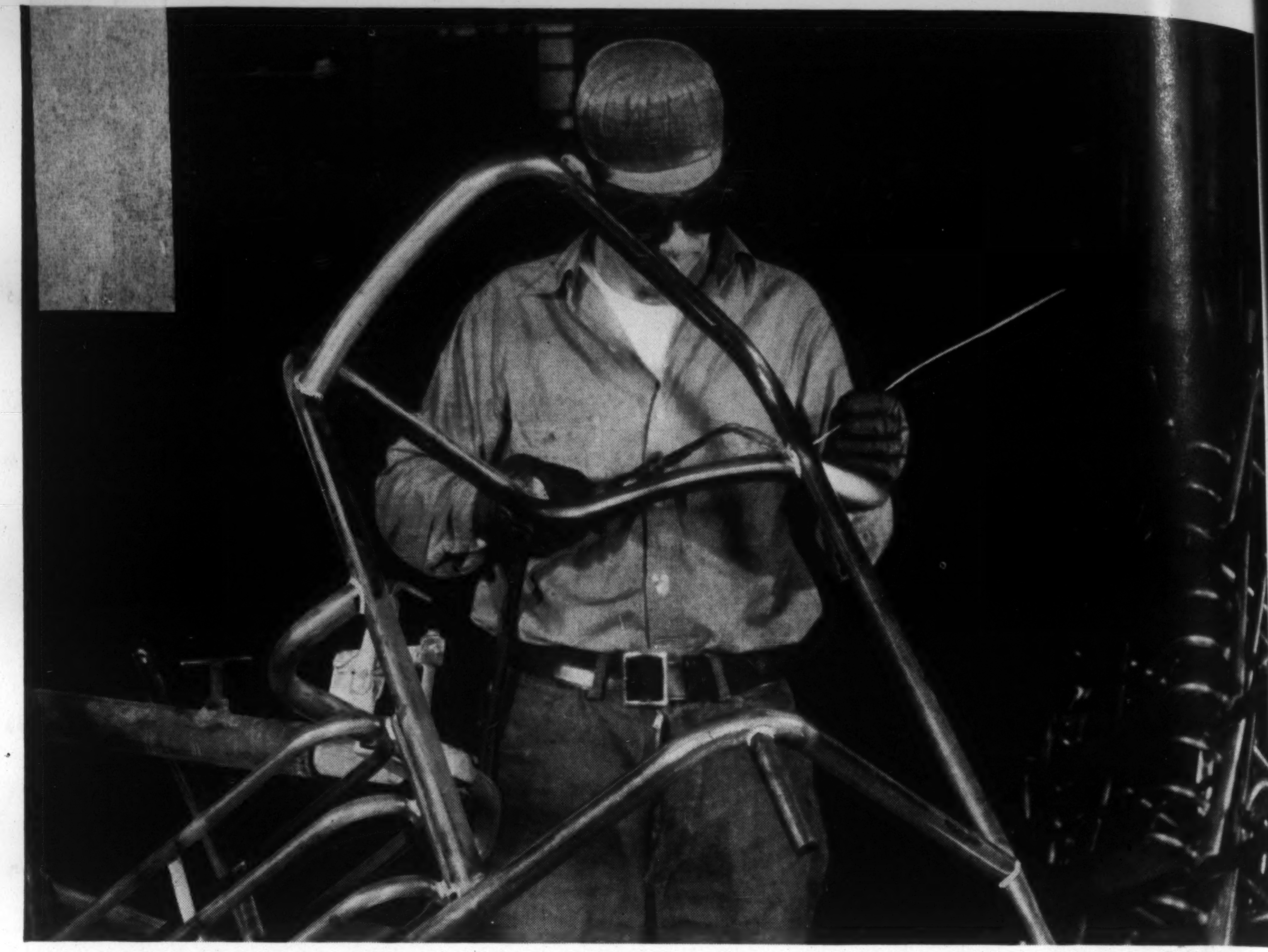
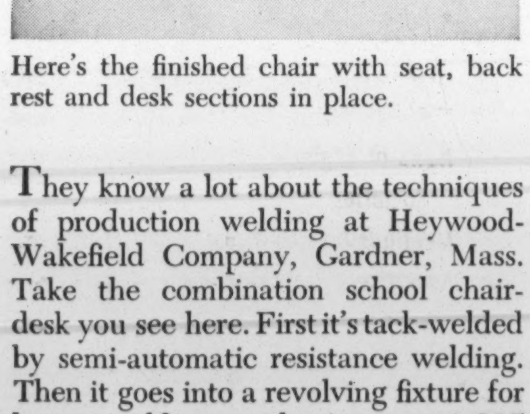


A revolving fixture holds this tubular steel chair-desk while the weldor brazes the joints with ANACONDA-997 (Low Fuming) Bronze Welding Rod. Heywood-Wakefield Company began producing welded steel tubing back in 1910. Today, they are leading manufacturers of tubular steel schoolroom furniture, bus, subway, railway car and theater seating.

here's production speed . . .

23 braze welds in 17 minutes



Here's the finished chair with seat, back rest and desk sections in place.

They know a lot about the techniques of production welding at Heywood-Wakefield Company, Gardner, Mass. Take the combination school chair-desk you see here. First it's tack-welded by semi-automatic resistance welding. Then it goes into a revolving fixture for braze welding with ANACONDA-997 (Low Fuming) Bronze Welding Rod and the flame-fluxed oxyacetylene process. The weldor swings the assembly to reach all joints from one position, completing the 23 welds in an average time of 17 minutes.

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Materials Engineering in Product Design & Manufacture

Materials & Methods®

JUNE 1955 **VOL. 41, NO. 6**

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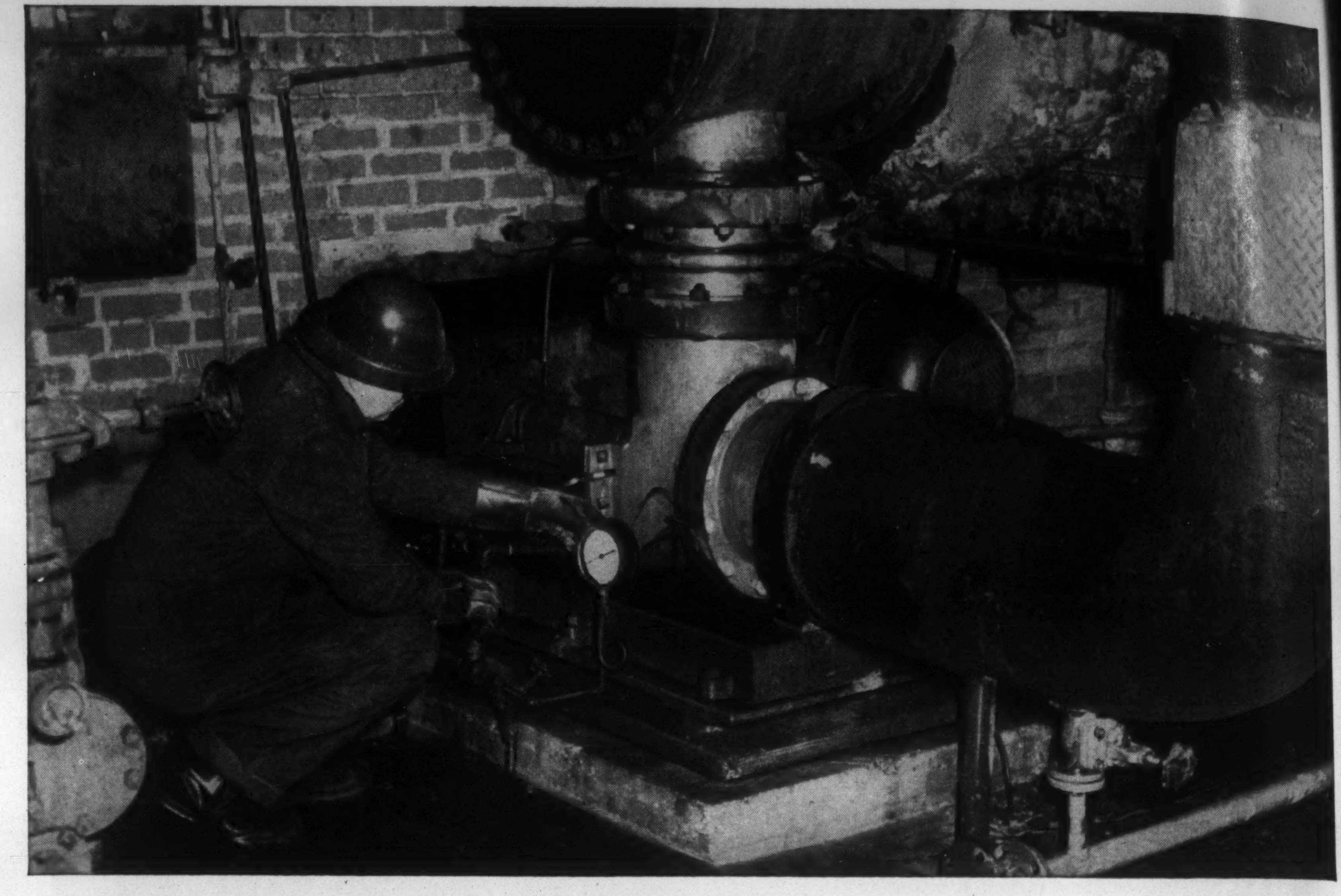

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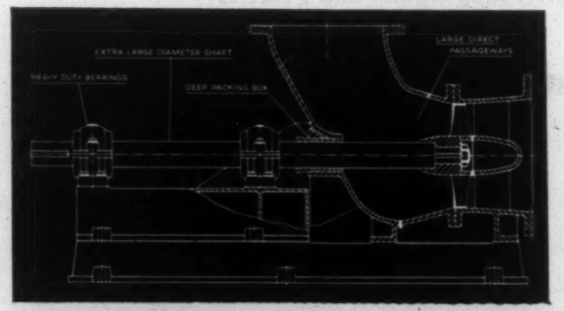

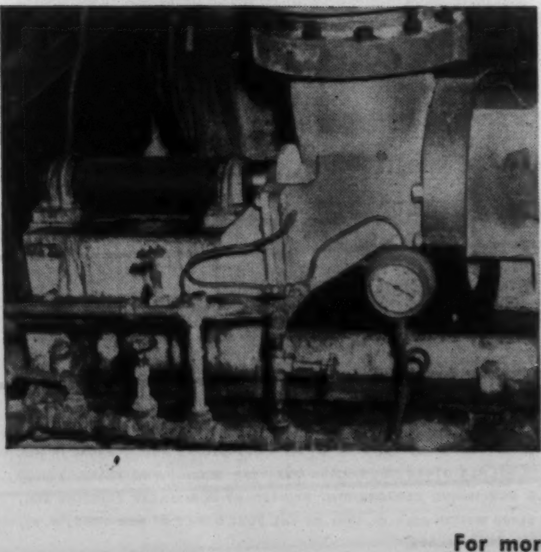

This *was* a trouble spot.

For this pump dwells in corrosives, potassium and sodium hydroxide with carbonates and organic impurities.

Once tinkering was constant . . . "down-time" high. Now, for eight months, only packing has been needed. Once 41 days to two years life was "max." Now, engineers expect five years. Once the pump was made conventionally. Now, it's "G"® Nickel cast by Inco.

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Materials Outlook

COST OF METAL STRIP may be cut by a new continuous casting machine which, if it proves successful, may make conventional strip-producing methods obsolete. The machine has already produced pilot plant quantities of high-quality steel, aluminum, magnesium and brass strip down to ¼ in. Upper limit on speed is virtually unlimited, and thicknesses down to 1/8 or 1/16 in. are believed to be possible. Unlike strip made by earlier continuous casting machines, the strip is claimed to be virtually free of segregation.*

SOME OF THE IMPACT EXTRUSIONS now being made would have been thought impossible a short time ago. Until recently it was generally believed that the process was limited to a few of the more ductile metals, to parts having symmetrical contours, and to parts with a maximum height of six times the diameter (for backward extrusion). Parts are now being made from many nonferrous metals and some steels, of unsymmetrical shapes, and with dimensions such that working stresses exceed the theoretical breaking strength of the tool steel. A comprehensive report on impact extrusions will appear in the August issue.

ZIRCONIUM INGOT PRICE has been slashed about 35%. Commercial grade now sells for $14.40 a pound instead of $22. Low-hafnium grade sells for about $23 instead of $33. Sponge prices are now about $10 and $14 respectively.

A NEW SYNTHETIC RUBBER said to have many favorable properties far exceeding those of any available commercial rubber, is now being field-tested by du Pont. The urethane rubber is claimed to have outstanding toughness and abrasion resistance, flexibility at temperatures as low as -90 F, and resistance to oils, oxygen, ozone and weathering.

TWO DEVELOPMENTS IN COLORED ALUMINUM have been announced: vitreous-enameled castings and integrally-colored sheet and strip. The foundry now applying vitreous coatings to permanent mold and die castings expects that the new finish will be specified not only where high-gloss colors are desired, but also where good abrasion resistance, chemical resistance or insulating properties are needed. The colored sheet and strip, expected to be available soon, are said to be the result of a new electrochemical process which makes possible a great variety of colors impregnated in the aluminum surface, yet "identical to a baked-on enamel finish in opacity and gloss". The material can be roll-formed or shallow drawn without damage to the finish.

---

* Watch for a forthcoming M & M article on this subject.

Materials Outlook

A NEW TYPE OF CLAD METAL PLATE is available. It is made by brazing on alloy sheet to the base plate while holding a vacuum between the two metals. Combinations now being made include nickel, nickel alloys, chromium steels or chromium-nickel steels, all backed by carbon steels. Since the alloy layer is not rolled down, thinner alloy layers can be specified without fear of corrosion failure at thinned-out areas.*

WELDED PLASTIC STRUCTURES, widely used in Germany, have been slow in gaining acceptance in this country, but a plastics industry spokesman looks for increasing use in coming years. Backing up his prediction are continuing improvements in structural plastics, especially unplasticized polyvinyl chloride; impending standardization of PVC; and current efforts to develop specifications for design and fabrication. Attention has been focused on this field recently by the erection of a large all-plastic exhaust system at the Naval Gun Factory in Washington.

REFERENCE RADIOGRAPHS covering types and degrees of discontinuities in steel welds have been issued by the ASTM.

UNALLOYED TITANIUM POWDER METAL PARTS with higher ductility and lower strength than wrought unalloyed titanium are being made by vacuum sintering. Properties similar to those of A-70 are obtained by adding small quantities of aluminum, manganese or tin, rather than increasing oxygen content. The same company has made powder metal parts having composition and properties similar to that of C-130AM, but with better impact resistance. . . . Titanium producers seem confident they have solved the major problems of metal quality that for a time threatened to curb the growing use of the metal in military applications. As a result, they expect increasing amounts of titanium to be specified by airframe and aircraft engine manufacturers in the near future. . . . A major producer claims the Kroll process probably holds more promise for eventual cost reduction than any other process so far developed. . . . Most important single factor in easy machining of titanium, according to one expert is, "getting the coolant to the tip of the tool."

MODIFIED NEOPRENE having most of the favorable properties of conventional neoprene but costing a few cents a pound less may soon be available. A new reclaimed rubber compound can be added to neoprene in considerable quantities to produce a material having somewhat greater compression set than neoprene but aparently equivalent oil resistance, weathering and heat aging properties.

---

* Watch for a forthcoming M & M article on this subject.

Materials BRIEFS

Antimony Glass

New glasses based on antimony oxides rather than silicon oxides will transmit a greater range of infra-red waves. The glass, which will transmit longer wave lengths than water, can be rendered opaque to the visible light range with very little attenuation of longer infra-red waves.

Another Handle

A manufacturer of carpenters' hammers has introduced a premium grade hammer with fiber glass reinforced plastics handle. The handles have good impact characteristics, will not swell or shrink over periods of protracted use.

Aluminum License

States with permanent automobile license registration have found that aluminum license plates need be replaced only once in five years. Six states now issue aluminum plates—some on an annual basis. Those states that mail plates to car owners have found that postage savings result in significant economies.

No Strain

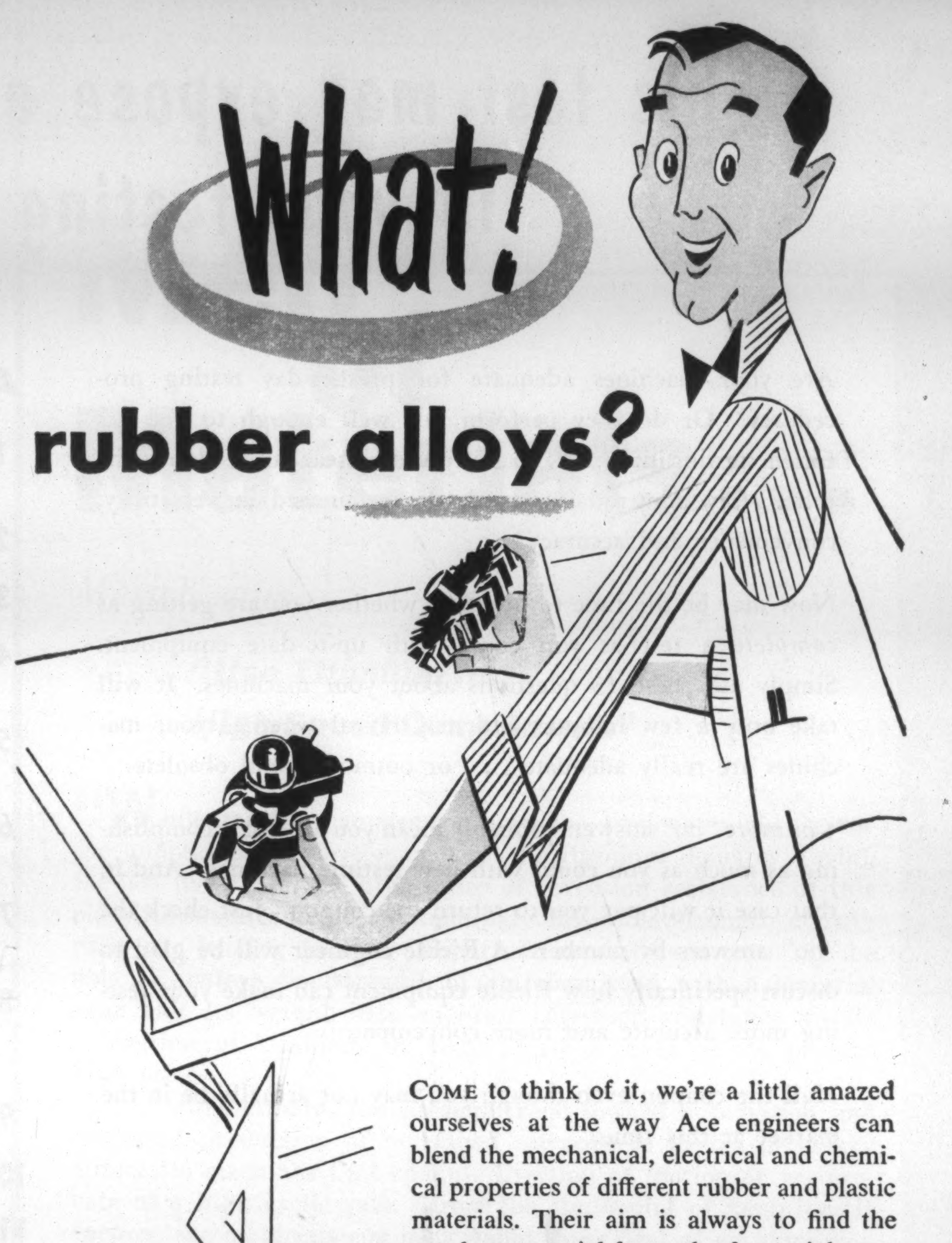
A new vinyl sheet specially prepared for deep drawing offers freedom from internal strains to the extent that much better register of designs printed on the flat sheet can be obtained.

Circuit Circus

The expanding printed circuit electronics business is expected to consume more than $3 million worth of copper clad plastics laminates this year. 1955 volume should triple or quadruple last year's record.

Fluorocarbon Hose

A high-temperature plastics hydraulic-line hose has been developed that will resist chemical attack at temperatures as high as 400 F. Using tetrafluoroethylene resin, the hoses are expected to find application in aircraft.


What!
rubber alloys?

COME to think of it, we're a little amazed ourselves at the way Ace engineers can blend the mechanical, electrical and chemical properties of different rubber and plastic materials. Their aim is always to find the one best material for each of your jobs . . . never *over*designed . . . with production economy a must. Result: hundreds of tailor-made rubber, plastic, and rubber-plastic alloys to choose from . . . plus many unusual materials like Ace-Tex pyrobitumens. Ask us for anything from rough-ground rods to finished molded assemblies. Our facilities for molding, extruding, fabricating, and lining are among the world's largest.

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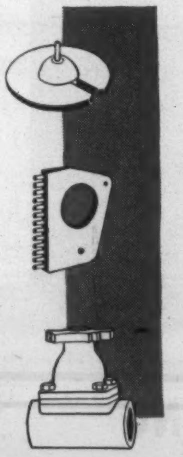

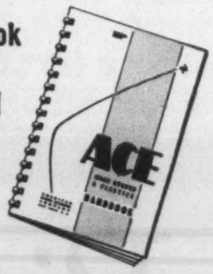

This test may expose a "has been" in your testing lab

Are your machines adequate for present-day testing procedures? Or do they perform just well enough to get by? Often, testing machines in daily use appear to be doing the job . . . yet by today's standards are limited in versatility, convenience and accuracy.

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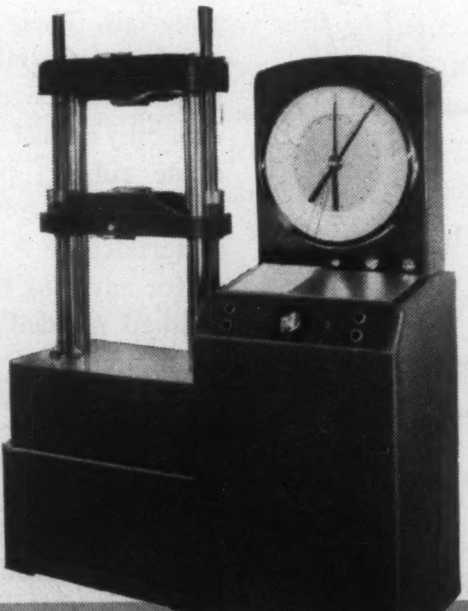
Mail the coupon even though you may not actually be in the market at this time.



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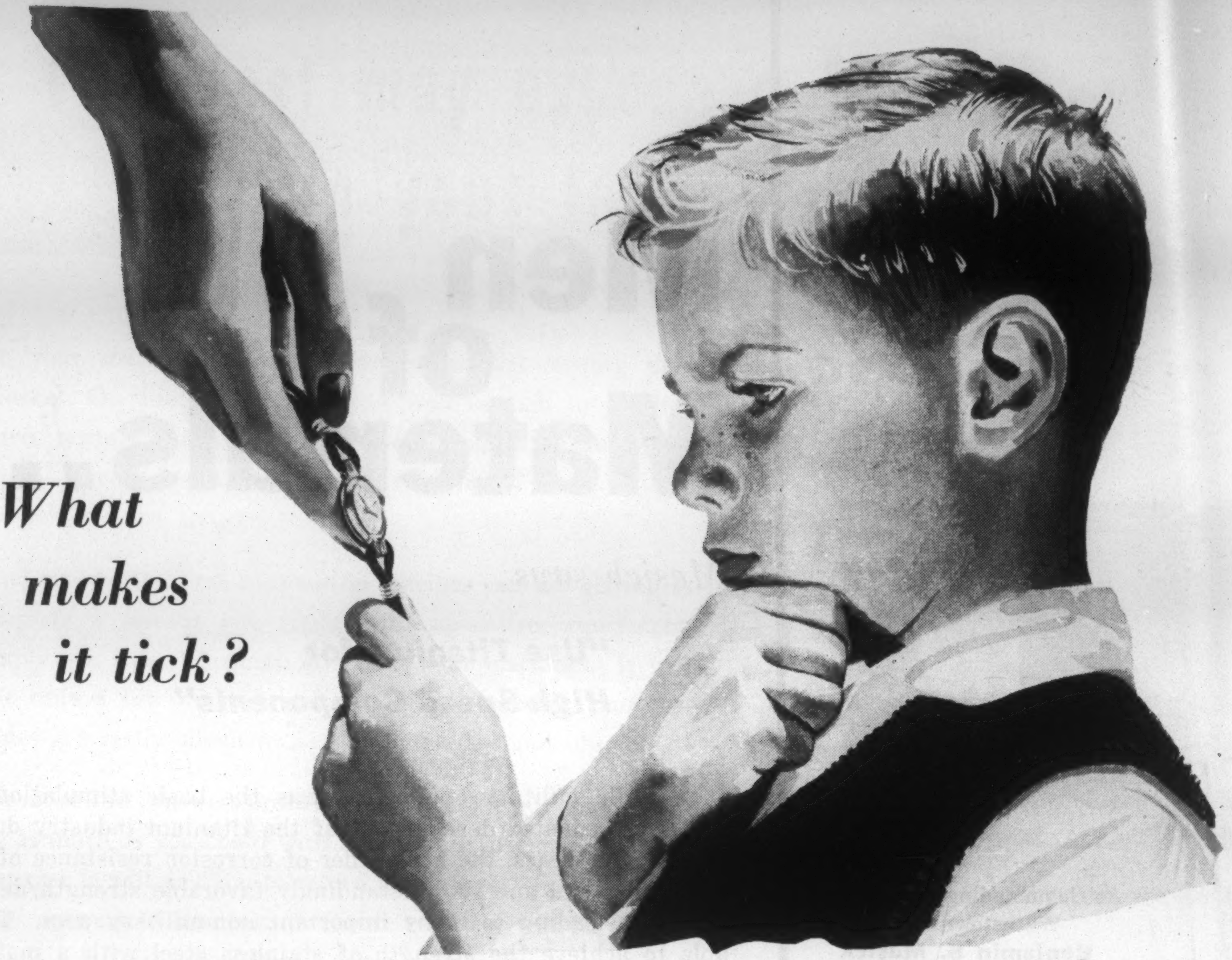
As Commanding Officer of Watertown Arsenal, **Benjamin S. Mesick** established the Ordnance Materials Research Office of the U. S. Army and coordinated the Army's Titanium Development Program. Col. Mesick retired in 1954 after 30 years of government service and has since joined the staff of Arthur D. Little, Inc., where he will be responsible for expanding the company's activities in the titanium field. A graduate of West Point, Col. Mesick also studied at M.I.T., where he earned a D.Sc. He has been engaged in developing applications for titanium outside the aircraft field since 1950.

"While military application was the basic stimulation for the unprecedented development of the titanium industry during the last five years, the high order of corrosion resistance of this plentiful metal and its outstandingly favorable strength/density ratio are leading to many important non-military uses. To be able to achieve the strength of stainless steel with a material near half its weight with superior corrosion resistance merits utilization of titanium in many designs, even at its present high price.

"Furthermore, the present trend toward automation and increased production of machined components makes necessary automatic machines that change direction of motion or reciprocate at a high cyclic rate. From the standpoint of mass-inertia factors, the materials engineer would think first of an aluminum or magnesium alloy, but in most cases, such materials would not meet the strength or impact requirements. Titanium alloys are available commercially which will meet all physical requirements and at the same time permit indefinite use at a much higher operating rate.

"In considering any engineering material, it is essential to take wearing properties into account. Poor wear resistance and, particularly, tendency to gall or seize, has delayed certain applications of titanium which involve sliding contact under load. Research is offering promise of relief on this problem. Methods of plating titanium with nickel or chromium and various types of surface treatment are being developed.

"Reliable statistics indicate that only 2% of the 5,000 tons of wrought titanium produced during 1954 found its way into non-military products. It seems reasonable to expect the non-military figure to double during 1955 and ultimately to exceed the military utilization of titanium."



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As the wrist moves, a tiny balance weight of Mallory 1000 Metal swings back and forth inside this dainty self-winding watch and keeps the spring wound just right.

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Modulus of Rupture (simple beam, center loaded)	220,000 psi	180,000 psi
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MATERIALS ENGINEERING **News Digest**

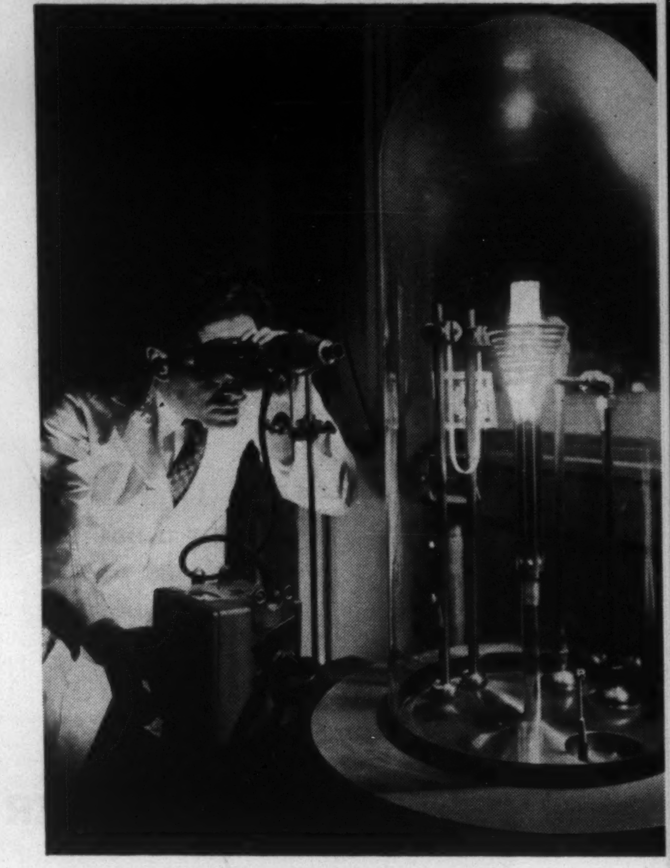
Cage Refining Purifies Titanium

Many a farmer knows that a keg of hard cider left out to freeze will solidify from the outside-in and leave a concentrated solution of alcohol and cider in the center. A new process called cage refining, developed at Westinghouse, uses the applejack principle combined with induction heating to purefy ingots of titanium.

The process works by melting the center of a fluted ingot of metal by induction while maintaining a solid outside skin on the ingot. By passing the ingot through the heating field, impurities with a preference for the liquid state are collected in the liquid core and moved to one end of the ingot. Thus the ingot acts as its own crucible and is somewhat comparable to skull melting. The method is expected to be useful with highly active metals such as silicon and titanium, which react with almost all known crucible materials.

The new technique was developed by P. H. Brace and Dr. G. C. Comenetz, consultants, and Dr. A. W. Cochardt of Westinghouse's Metallurgy Dept.

Dr. Comenetz, said "The new technique applies the valuable [zone refining] technique to metals which are so active at high temperatures that they react with any crucible in which we could heat them." He said the technique would provide purities comparable to that of zone melted germanium, which is commonly purified to one part in ten million for use in semiconductor applications. "Titanium has a melting point of more than 3000 F," Dr. Comenetz added, "At this temperature it is one of the most active metals known. It not only oxidizes rapidly, but reacts chemically with metal, graphite or ceramic containers. Our technique eliminates such sources of contamination during refining."



***Titanium rod** rises through induction coils as metallurgist keeps tabs on temperature with pyrometer.*

The process operates in a low pressure inert atmosphere of helium or argon. A square or fluted bar of impure metal is raised through an induction heating coil. Using a current alternating at 10,000 cps, the center of the bar is melted by induction. The four corners of the square bar, or the fluted ridges on a round bar are less affected by the induced currents and rapidly lose what heat they do collect to the surrounding atmosphere. Thus the molten material is kept in a cage of its own material. Westinghouse technicians foresee the technique being applied to bars three or more inches in diameter and of almost unlimited length.

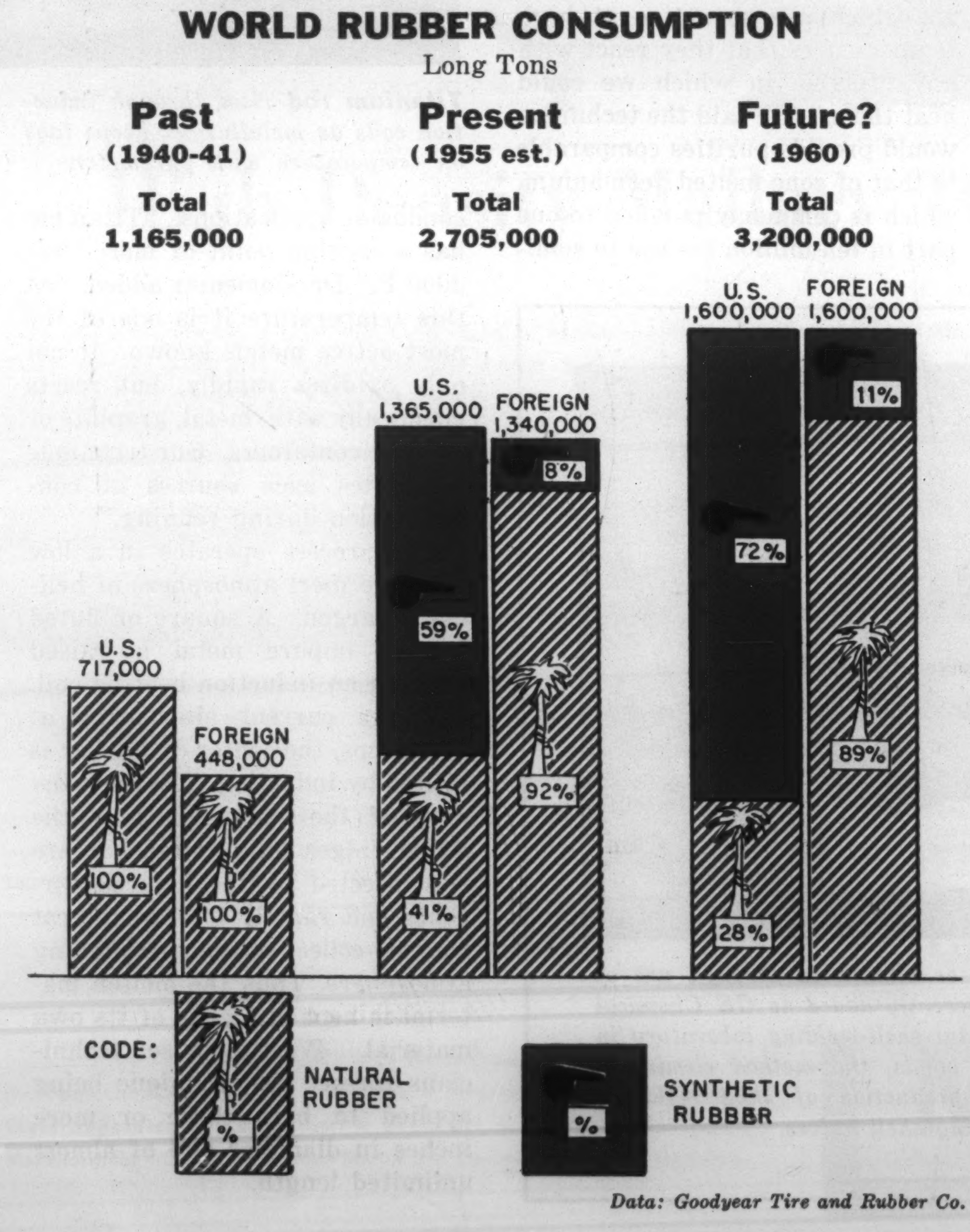
***Shell-molding bottleneck** may be eliminated through use of this new shell-bonding machine, recently added to GE Chemical Materials Department's experimental shell-molding laboratory in Pittsfield, Mass. Using adhesive bonds, the method eliminates mechanical fasteners. Hitherto, production of shell moldings lacked an effective method of joining shell halves.*

Government Sells Synthetic Rubber Plants

The bulk of U. S. synthetic rubber capacity now belongs to private industry. Of the 27 government owned GR-S and butyl rubber plants, 24 have been sold and one leased. Only two remain in government hands. The disposition of one is in doubt, and the other has had bids submitted for its purchase.

What it means

Private ownership by a number of independent companies of the government's synthetic rubber monopoly will bring a number of changes in products, research, prices, and marketing techniques. The synthetic rubber industry was built under wartime pressure to replace the natural rubber cut off by the Japanese in the Far East. It remained a government monopoly, with plants operated under contract to private organizations. Under government regulations any and all research applied to GR-S and butyl rubber was conducted under government sponsorship, and new developments, regardless of source, were available to the entire synthetic rubber industry. The price structure of synthetic rubber did not reflect individual producers costs, but was worked out on the basis of average return. The high cost plants operated at a loss, made up by the low cost plant's profits. Under the old system, there was little pressure for cost-cutting and rigorous applied research programs to improve products. Private companies concentrated their research on other elastomers, or neglected to do any research in synthetic rubber at all.



Data: Goodyear Tire and Rubber Co.

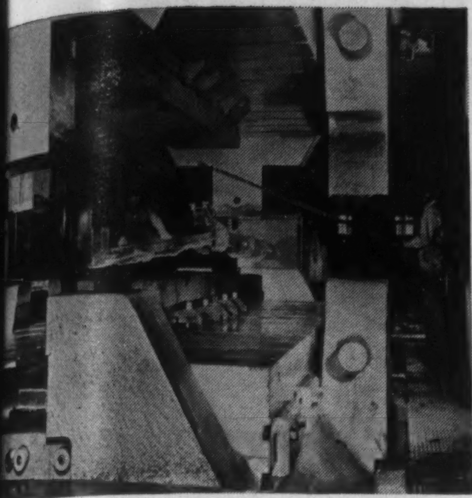
The production facilities sold to corporations still have some strings attached. In case of national emergency the plants will revert to government control, and the possibility of a monopoly by a few large producers has been sidestepped by government regulations requiring that a share of the production of all the plants must be available to independent rubber goods manufacturers.

Not all of the ex-government-owned plants that were sold produce rubber; eleven turn out basic chemicals used in the manufacture of synthetic rubber only. Of the remaining 13 plants, two are butyl rubber producers with a combined capacity of 90,000 tons per year. The remainder of the plants turn out GR-S, and their production totals 690,000 tons per year, or more than a quarter of the total world consumption of all types of rubber (see graph).

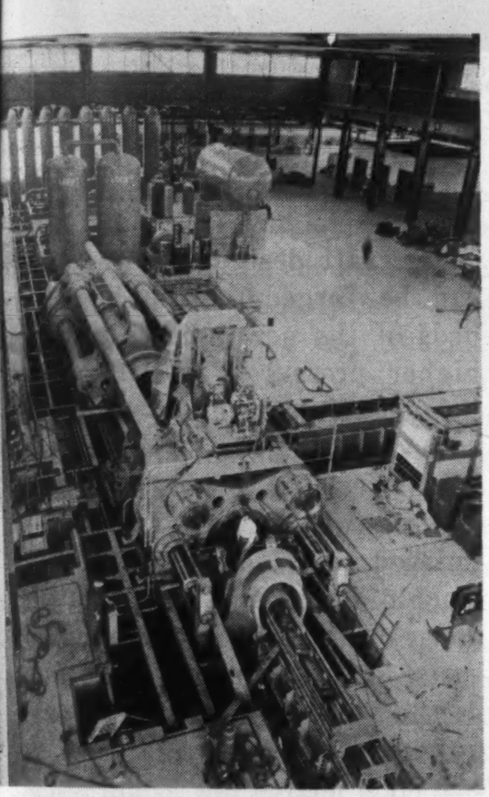
Marketing changes coming

One of the first effects of the private ownership of synthetic production will be a gaggle of new brand names for different types of GR-S. This will happen, industry sources believe, along with an actual decrease in the number of formulations of GR-S available to purchasers. Government plants have been highly cooperative about turning out small amounts of specialized elastomers on special order, but these high cost practices will undoubtedly decline when the customer has to pay the bill. In general, prices are expected to stay about the same as they were before the

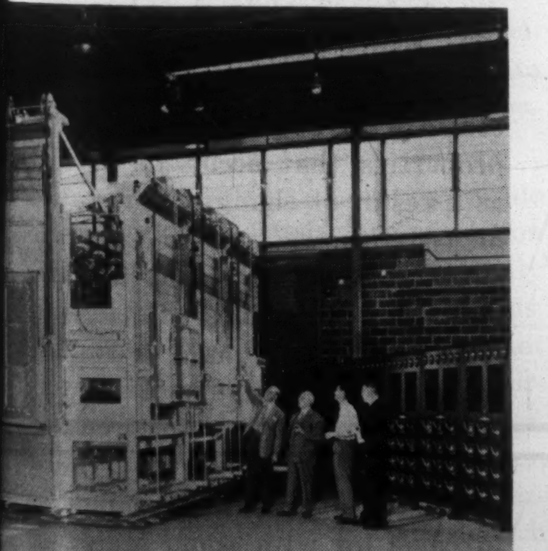
(Continued on page 233)



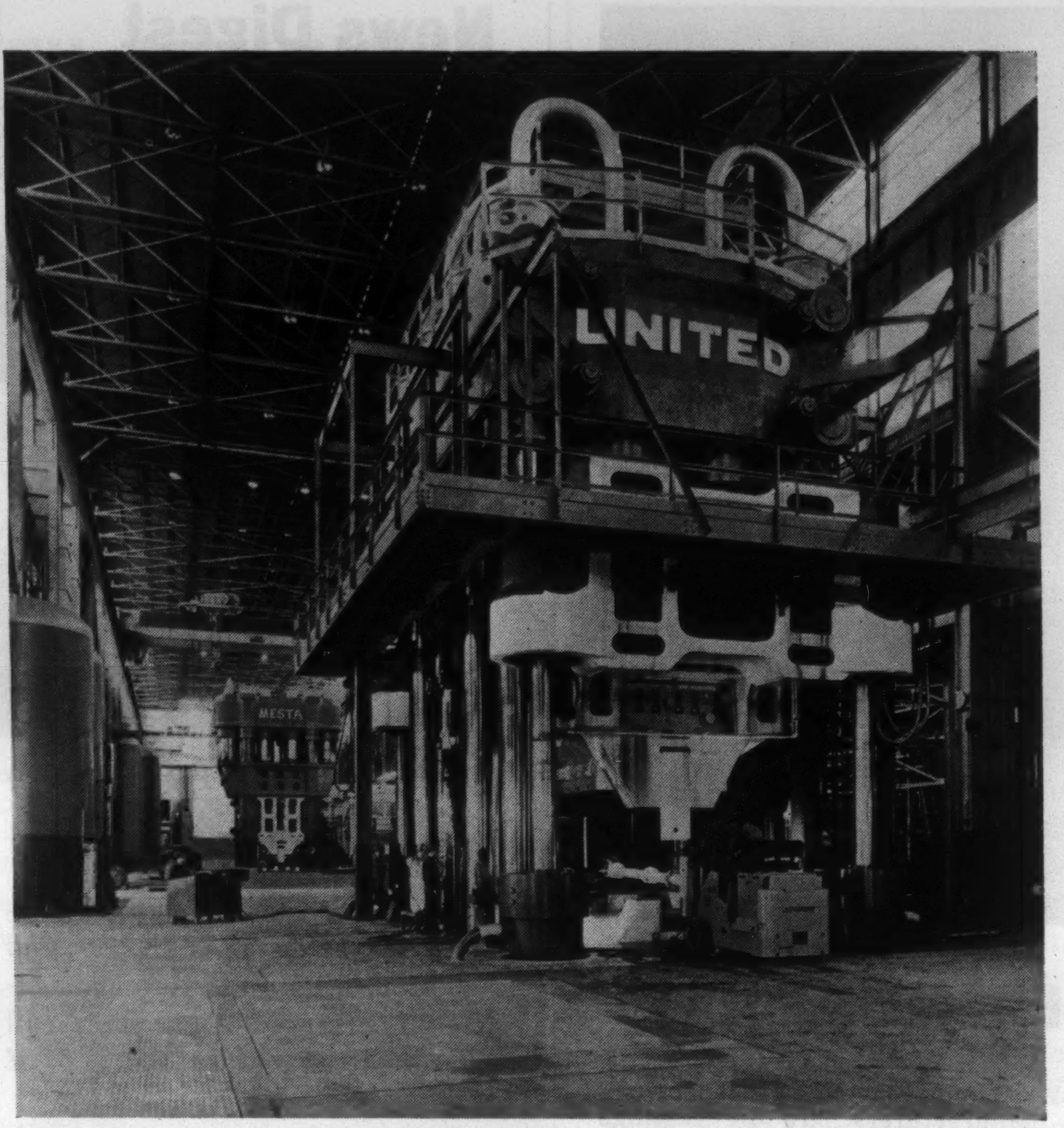
Wing spar forging *is pulled from die of 35,000-ton press after blocking operation. Workmen stand by to lubricate dies.*



Heavy extrusion press, *rated at 12,000 tons, is readied for operation at Curtiss Wright Corp.'s Buffalo plant.*



World's largest electric steel forging furnace *built for Heavy Press Program by C. I. Hayes, Inc.*



Now operating, *Alcoa's 35,000- and 50,000-ton presses are the second and third units to be completed. Fourth unit, at Wyman-Gordon, will complete heavy forging press program.*

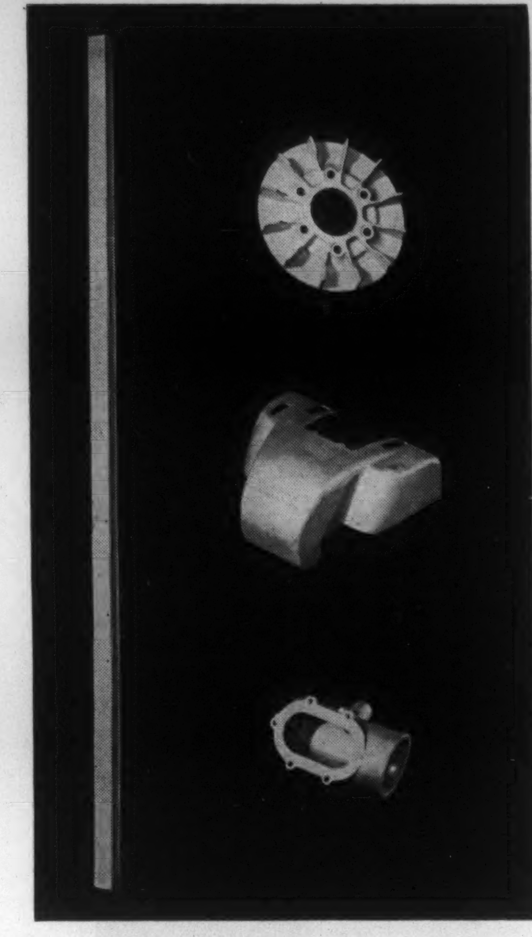
Two New Heavy Presses Start Production

With scarcely noticeable motion, the jaws of the first 50,000-ton closed die forging press clamped shut on an aluminum billet at Alcoa's new forging facility in Cleveland, Ohio early last month. Watched by high industrial and Air Force officials, the occasion marked the climax of dedication ceremonies for the Air Force heavy press program, now more than half completed.

The Alcoa installation, consisting of the 35,000- and 50,000-ton Loewy presses and associated die shops, heat treating and material handling equipment is the first wholly completed unit in the press program. The over-all cost of the entire program, which includes four heavy forging presses and six heavy extrusion presses is estimated at $279 million.

Three of the four heavy forging presses are now in operation with the fourth, a 50,000-ton Loewy press, scheduled for operation by late summer. Wyman-Gordon Co., is the operator of the other forging press facility, which, like Alcoa's, will have 35,000- and 50,000-ton presses. Wyman-Gordon's 35,000-ton unit began production in April.

The extrusion presses contracted for by the Air Force are all approaching completion. Alcoa has had a 14,000-ton Schloeman unit in operation since May 1954, and Curtiss Wright started up its 12,000-ton steel extrusion press two months ago. The balance of the



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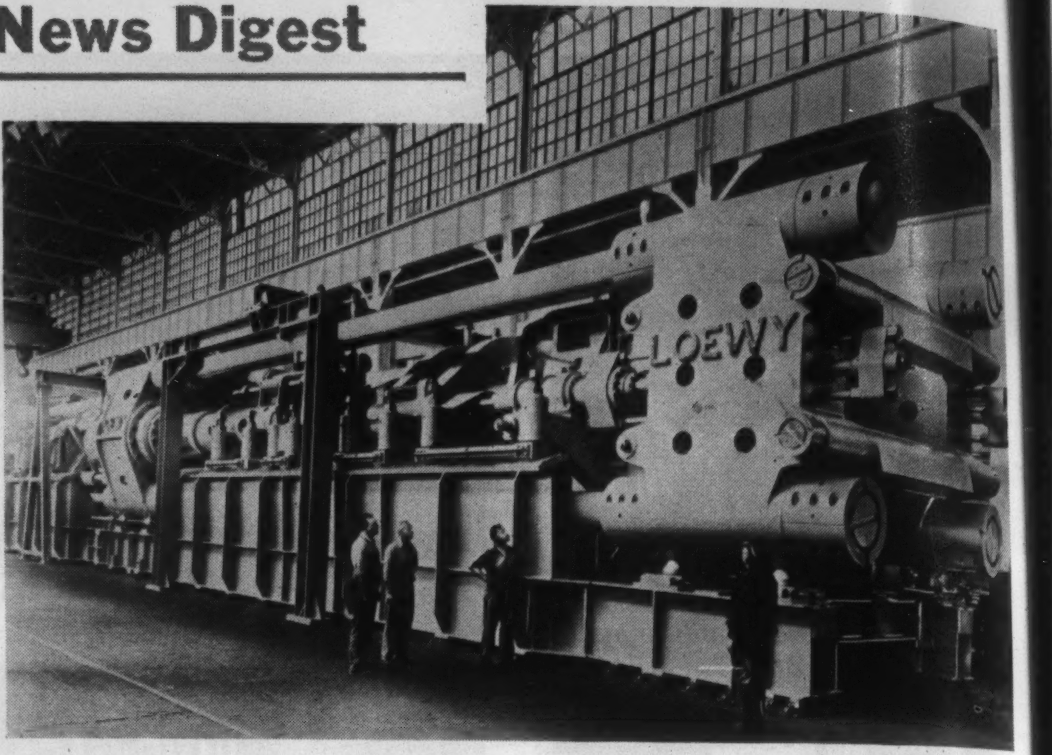
News Digest



Ready to go west, *8000-ton extrusion press will be shipped to Harvey Aluminum on 40 flat cars.*

presses, two 8000-ton units managed by Alcoa, and 12,000- and 8000-ton units under the management of Harvey Aluminum, will be completed before the end of this year.

The big forging presses rank among the world's largest machine tools. Weighing more than 6000 tons, they are as tall as an eight story building. The castings and forgings fabricated for their construction are among the largest ever handled.

The heavy forging presses are expected to have a telling effect on aircraft design. Larger parts can be forged on the huge die beds of the new presses, and the higher pressures available allow thinner ribs, thinner webs, and zero draft angles on large parts. The "precision forgings" that the presses can turn out are close to finished parts, and require little machining or finishing. Cutting down on machining not only cuts costs, but provides stronger parts as the grain flow pattern remains unimpaired.

ASTE to Investigate Borides for Tooling

The Research Fund Committee of the American Society of Tool Engineers has instituted a study of the possibility of the use of borides as cutting tools. Actual investigation will be carried out by the Ceramics and Minerals Department, Armour Research Foundation.

Relatively little is generally known about borides as tool materials, but some fantastic claims have been made for them. The ASTE Fund will seek to prove or disprove such reports.

Like ceramic cutting tools (M&M-April), the borides hold the possibility of releasing critical tungsten supplies for other uses. Many borides can be produced from relatively abundant, inexpensive materials.

The ASTE investigation will collect data on the broad range of properties that occur in borides as a result of changing the ratios of constituents, varying particle sizes, and altering sintering temperatures and times. Borides of titanium, tantalum, zirconium, vanadium, chromium, molybdenum and tungsten will be thoroughly investigated.

The researchers hope to be able to come up with some materials that will at least duplicate the performance of carbides. Cutting tests should be underway within a year.

(More News on page 234)

DESIGNING WITH ALUMINUM

NO. 13

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

COLOR MATCHING OF ANODIZED ALUMINUM ALLOYS

Color matching, in the sense of "tone" or "shade," among the various aluminum alloys can be rather complicated. The degree of complication depends greatly upon the type of finish which is desired for the various alloys which might be used in making up an aluminum assembly.

Generally, the appearance of various wrought and cast alloys will vary slightly in the mill-produced condition because of different alloy constituents at the surface. The simplest way to achieve the most uniform color among the various alloys is to polish them mechanically. Practically all freshly polished aluminum alloys look alike. However, ordinary weathering or aging in industrial atmospheres will cause slight surface film reactions. The products of these reactions will differ for the various alloys. Generally, aluminum alloys retain a bright pleasing appearance despite extended exposure to the weather. A few alloys will darken upon weathering.

Alloys that contain silicon, such as 4043, and those that contain copper, such as 2024, are among the alloys which darken rapidly upon exposure in the unprotected condition. There is no way to prevent this except by anodizing, chemically coating or painting.

Chemical conversion coatings, while often providing satisfactory protection from the environment, are not usually suitable for decorative applications. If a good permanent color is important to a design, and if painting is not desirable, anodizing is necessary. In a situation such as this a very careful selection of alloys must be made before anodizing in order to obtain a good color match—or contrast if it is desired. All alloys will exhibit slight to marked color differences after being anodized. Some alloys are fairly close in anodized color, especially when the anodic coating is not too thick. Figure 1 shows both matching and contrasting anodized aluminum alloys.

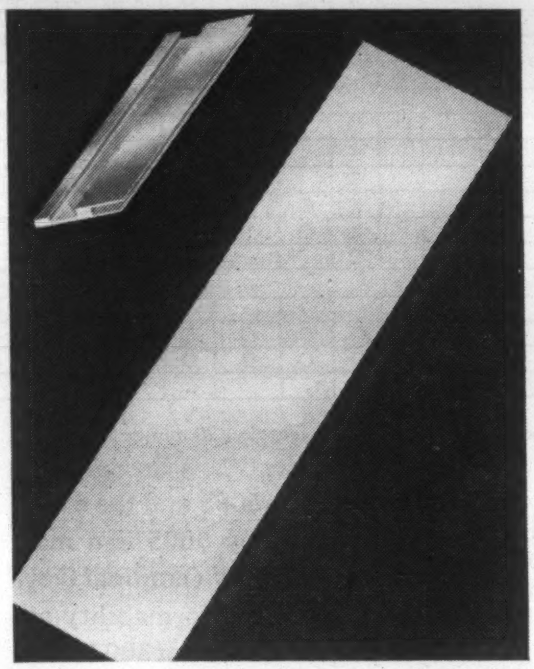


Fig. 1. Anodized 6063 extrusion alloy and 5005 sheet alloy lie side by side on a sheet of anodized 4043 sheet alloy which is quite dark. Notice that the 6063 and the 5005 match each other in color value but contrast sharply with the 4043.

A recognition of the technical principles which must be employed in the selection of the various alloys for color matching of their anodic coatings is of value in many applications of aluminum. In the architectural field alone the subject of color matching in anodized aluminum is assuming greater importance. Almost daily aluminum usage increases in such things as curtain wall construction. Table 1 lists many of the aluminum alloys in general use today and shows the approximate color matches obtainable through anodizing. For maximum color similarity slight variations in the anodizing process are necessary and should be established by the processor. The chemical compositions and tempers of the alloys are the basic reasons for differences in color after anodizing.

The commercially pure materials, such as 1100, EC, 1180 and the cladding material of Alclad alloy 2024, all exhibit relatively good color matches after anodizing. Those Alclad alloys which employ 7072 as the cladding, e.g. 3003, 3004, 5050, 6061 and 7015 will match well after anodizing. As a class, alloys containing magnesium provide relatively good matches, especially if the anodic coating is of moderate thickness. The magnesium content exerts a slight influence upon the color, but the purity of the alloy base is even more important. As a general rule, the higher the purity of the alloy base, the more transparent and the brighter the appearance of the anodic coating. Thus, anodized 5052 is brighter than anodized 5050.

Alloys containing copper, for instance 2014 and 2024, generally develop dark unattractive coatings when anodized in the annealed condition. The same alloys, when properly heat treated and quenched, may give relatively clear, attractive anodic coatings that will approximately match anodic coatings on alloys 1100 and 5005. A similar situation exists for 7075 alloy.

The high silicon alloys, such as No. 43 and No. 380 which are frequently employed in castings, present a very difficult problem since the silicon constituent darkens upon anodizing and, with sufficient anodic coating thickness, may be quite black. It is impossible to match such anodized casting alloys with most other aluminum alloys in the anodized condition. A match is possible with alloy 4043.

Aluminum casting alloys containing principally magnesium rather than silicon, on the other hand, match reasonably well with most other alloys. Casting quality and technique have an

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DESIGNING WITH ALUMINUM No. 13 Continued

TABLE 1

APPROXIMATE COLOR MATCHES OF ANODIZED ALUMINUM ALLOYS

O = Relatively Good Matching X = Better Matching

	Sheet and Plate Alloys																	Extrusion Alloys						Casting Alloys			
Sheet and Plate Alloys	1180	1100	2014*	2024*	Alclad 2024	3003	Alclad 3003	Alclad 3004	4043	5005	5050	Alclad 5050	5052**	6061	Alclad 6061	7075*	Alclad 7075	1100	3003	2024*	6061	6063	7075*	43	A214	A218	380
1180	X	O			O													O									
1100	O	X	O	O	X					O						O		X		O			O				
2014*		O	X	O						O								O		O					O	O	
2024*		O	O	X						O								O		X					O	O	
Alclad 2024	O	X			X													X									
3003						X													X								
Alclad 3003							X	X				X			X		X								O	O	
Alclad 3004							X	X				X			X		X								O	O	
4043									X															X			X
5005		O	O	O						X	O		O	X		O		O		O	X	X	O		O	O	
5050										O	X		O	O		O					O	O			O	O	
Alclad 5050							X	X				X			X		X								O	O	
5052**										O	O		X	O							O	O			O	O	
6061										X	O		O	X							X	O			O	O	
Alclad 6061							X	X				X			X		X								O	O	
7075*		O								O						X		O					X		O	O	
Alclad 7075							X	X				X			X		X								O	O	
Extrusion Alloys																											
1100	O	X	O	O	O					O						O		X		O			O				
3003						X													X								
2024*		O	O	X						O								O		X					O	O	
6061										X	O		O	X							X	O			O	O	
6063										X	O		O	O							O	X			O	O	
7075*		O								O						X		O					X		O	O	
Casting Alloys																											
43									X															X			X
A214			O	O			O	O		O	O	O	O	O	O	O	O			O	O	O	O		X	O	
A218			O	O			O	O		O	O	O	O	O	O	O	O			O	O	O	O		O	X	
380									X															X			X

* Heat treated and quenched ** For relatively thin anodic coatings, i.e., not exceeding 20 min anodizing

even greater influence on anodizing characteristics than does the alloy composition.

Among the sheet and plate alloys it is almost impossible to match alloys containing manganese, such as 3003, with other alloys as far as color in the anodized condition is concerned.

Some examples of compatible pairs for anodizing are 5005 and 6063, 5005 and 6061, 1100 and Alclad 2024. Numerous other examples may be chosen based on the principles outlined above. Of special interest to designers and engineers who are concerned with building materials and architectural design, is the excellent color match which may be obtained in the anodized condition with the sheet alloy 5005 and the extrusion alloy 6063. Alloy 5005 is a magnesium-containing alloy (nominal 0.8% Mg) with strength and formability approximately equal to those of 3003 alloy. Alloy 6063 is the extrusion alloy which is employed almost universally in window frame molding and store front trim. Where an architect wishes to use an anodized sheet product close to an anodized 6063 extrusion, a definite clash in color will result if alloy 3003 is employed as the sheet material. However, alloy 5005 when employed in place of alloy 3003, exhibits an excellent color match with 6063 when both alloys are anodized to the same coating thickness.

The understanding and application of the principles affecting the colors of anodized aluminum alloys will provide the means for attractive architectural design work. These same principles will undoubtedly influence the choice of aluminum alloys for products outside the field of architecture.

Further information concerning the color matching of anodized aluminum alloys may be obtained from the Kaiser Aluminum sales office listed in your telephone directory, or through one of our many distributors. Kaiser Aluminum and Chemical Sales, Inc. *Executive Office:* 6676 Kaiser Building, Oakland 12, California; *General Sales Office:* Palmolive Building, 919 North Michigan Ave., Chicago 11, Illinois.

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Static and Centrifugal Castings. Duraloy Co., 16 pp, illus, No. 3354-G. Describes facilities for producing high alloy static and centrifugal castings. Engineering data on castings for heat, corrosion and abrasion resistance. (21)

Industrial Furnaces. Despatch Oven Co., 6 pp, illus, No. 84. Describes low-cost precision heating furnace operating within 275-850 F range. (22)

Vapor-Spray Degreasers. Detrex Corp., 4 pp, illus. Open top degreasers for pure vapor degreasing, spray flushing with oil-free solvent distillate and final pure rinse. (23)

Barrier Materials. Dobeckmun Co., 4 pp, illus. Flexible packaging materials: combinations of polyethylene, Kraft paper, scrim cloth, vinyl, aluminum foil, wax. (24)

High Alloy Steels. Electric Steel Foundry, 8 pp, illus. Discusses factors to be considered in choosing between cast and wrought metal structures. (26)

Studs and Bolts. Erie Bolt & Nut Co., 60 pp, illus, No. 446. Catalog of company's available nuts, bolts and studs. Price lists given. (27)

Metallized Ceramic Coating. Frenchtown Porcelain Co., 4 pp, illus. Metal-to-ceramic coating produces surface to which metal part or other metallized ceramic parts may be soft or hard soldered without special preparation. (28)

Tooling Resins. Furane Plastics, Inc. Analysis of types of laminating and casting resins for plastic tooling applications. (29)

Polyvinyl Chloride Resin. General Tire & Rubber Co., Chemical Div. Illustrated folder on polyvinyl chloride resin for calendering, extruding and molding operations. (30)

Brass Products. Grand Rapids Brass Co. Div., 16 pp, illus. Describes facilities for brass parts production. Includes examples of parts available. (31)

Aluminum Bus Conductors. Kaiser Aluminum & Chemical Corp., 12 pp. Discusses methods of joining and bending aluminum electrical bus conductors. Covers rectangular bar, tubular conductor and solid, round bar. (32)

Sintered Carbides. Kennametal, Inc., 24 pp, illus, No. B-111. Composition, physical and mechanical properties and typical applications of various grades of sintered carbides. (33)

Atmosphere Control for Heat Treating. Leeds & Northrup Co., 20 pp, illus, No. TD4-620(1). How to control surface carbon content automatically in heat-treating steel. (34)

Constructional Alloy Steel. Lukens Steel Co., 18 pp. Properties and applications of low carbon, quenched and tempered alloy plate steel (T-1), available in thicknesses from ¼ in. to 6 in. (35)

Castings. Meehanite Metal Corp. Wall chart showing design and engineering properties of Meehanite castings. (36)

Thermostat Metal. General Plate Div., Metals & Controls Corp. Information on selecting thermal elements and their design. Tables give major mechanical and physical constants for various thermostatic metals. (37)

Phosphate Coating. Metalwash Machinery Corp., 8 pp, illus. Outlines use of phosphate coatings for protection of metal surfaces. Describes most common types of conversion coatings and explains mechanism of phosphate coating formation. (38)

Barrel Finishing. Minnesota Mining & Mfg. Co., 10 pp, illus. Gives basic steps involved in trial processing runs and recommendations for selection of media and compounds, barrel speeds, water level and time cycles for barrel finishing. (39)

Screw Machine Products. National Screw Machine Products Assn., 18 pp, illus. Guide to selecting proper screw machine products. Includes discussion of design, burring, heat treating and grinding. (40)

Vulcanized Fibre and Laminated Plastic. National Vulcanized Fibre Co., 16 pp, illus, No. NV-5572. Covers properties, grades and uses of vulcanized fibre and laminated plastic. Case histories included. (41)

Coated Strip Steel. Thomas Strip Div., Pittsburgh Steel Co., 20 pp, illus, No. TS-101. Strip steel pre-coated with zinc, copper, brass, lead alloy, nickel or chromium, natural planished or buffed finishes and rolled in patterns. Booklet includes 8 samples. (42)

Coil Forms. Precision Paper Tube Co., 4 pp, illus. Describes facilities available for the fabrication of coiled forms, precision bobbins, square and rectangular tubes, etc. (43)

Stainless Alloy Steel Castings. Quaker Alloy Casting Co., 4 pp. Reference chart gives specifications, designations, analysis, physical properties and heat treatment for stainless, corrosion and heat resistant alloy steel castings. (44)

Acrylic Emulsion Coatings. Rohm & Haas Co., 5 pp. Describes two acrylic emulsions, Rhoplex X-52 and B-85, possessing unusually hard films. (45)

Plastic Molding. Romar Plastics, Inc., 4 pp, illus. Describes company's facilities for all stages of plastic molding. (46)

Investment Casting. Scott Casting & Mfg. Co., 4 pp, illus. Case histories illustrate advantages of investment casting for complex parts. (47)

Rubber Stocks. Stalwart Rubber Co., 16 pp, illus. Information on type of rubber stocks from which company fabricates precision parts. Includes recommended applications. (48)

Temperature Indicator. Thermo Electric Co., Inc., 2 pp, illus, No. 61. Self-balancing indicator for rapid reading, or logging of many temperatures. Describes potentiometer, pyrometer and resistance thermometer. (49)

Weldbrazing. Uniworld Research Corp. of America, 4 pp, illus. Special steel filler alloys combine fusion welding and brazing process. Applicable to all types of gas and electric welding with standard welding equipment. (50)

Fabricating Stainless and Heat Resisting Steels. U. S. Steel Corp., 136 pp, illus, No. ADV-15595. Indexed handbook on fabrication techniques and properties of stainless and heat resistant steels. Includes text and tabular data on welding, soldering, heat treatment, finishing and protection, etc. (51)

Hard-Facing. Wall Colmonoy Corp., 4 pp, illus. Describes preparation, spraying and fusing operations and gives specific applications. (52)

Other Available Literature

Irons and Steels • Parts • Forms

Steel Weldments vs. Castings. Acme Tank & Welding Div., United Tool & Die Co., 20 pp, illus. Booklet furnishes basic facts about steel plate fabrication as compared to casting for manufacturers and designers of heavy machinery, equipment, service apparatus and components. (53)

Metal Products. Allied Metal Specialties, Inc., 4 pp, illus. Illustrates a variety of trays, racks, fixtures, tanks, crates, baskets, etc. produced by this company. (54)

Steel Casting Design. Atlantic Steel Castings Co., illus. Offers detailed information on how to economically design steel castings. (55)

Stainless Steel Piping. Babcock & Wilcox Co., 6 pp, illus, No. TB-356. Outlines methods of bending and joining stainless pipe. Discusses problem of light wall vs. heavy wall pipe. Table of dimensions and physical properties included. (56)

Low-Alloy Steel. Bethlehem Steel Co., 66 pp, illus, No. 353. Properties and features of Mayari*R steel for use in applications requiring high strength and good wear and corrosion resistance. (57)

Steel Tubing. Bundy Tubing Corp., illus. Steel tubing for various industrial applications. (58)

Wire Cloth. The Cambridge Wire Cloth Co., 84 pp, illus. Illustrates the many different types of wire cloth, their typical applications and specifications. (59)

Iron and Steel Castings. Campbell, Wyant & Cannon Foundry Co., 24 pp, illus. Describes types of gray iron and steel castings. (60)

Stainless Steel Heads. G. O. Carlson, Inc. Various lists of typical uses and dies available. Price lists included. (61)

Circular Steel Shapes. Commercial Shearing & Stamping Co., 24 pp, illus, No. P-3. Covers company's range of cold formed circular steel blanks, flanged and dished shapes, produced from stocked dies. (62)

Metal Stampings. Crosby Co., 40 pp, illus. Describes company's range of facilities for metal stamping. (63)

Custom Steel Parts. H. Disston & Sons, Inc., 16 pp, illus. Describes custom

Manufacturers' Literature

steel parts, how they are made and how to use and order them. (64)

Lead Bearing Steel. Peter A. Frasse & Co., 3 pp, No. 12. Engineering memorandum on Ledloy-A which machines at speeds faster than steels used for common screw stocks. Compares analysis, mechanical properties and machinability. (65)

Stainless-Clad Steels. Ingersoll Div. of Borg-Warner Corp. Folder describes IngAclad, 20% cladding of stainless steel bonded to backing of carbon steel. (66)

Alloy Spring Steels. International Nickel Co., Inc., 18 pp, illus, No. EZ-93/29. Reprint includes charts, tables and photo-micrographs of alloy steels used for hot-formed springs. (67)

Cold Finished Steel. Jones & Laughlin Steel Corp., 8 pp, illus. Physical properties of J&L "1200" free-machining cold finished steel for small parts. (68)

Stainless Steel Castings. Kolcast Industries, Inc., 4 pp, illus. Large stainless steel precision castings made by the frozen mercury process. (69)

Leaded Steel. LaSalle Steel Co., 4 pp, illus. Lists available forms of free-machining, open-hearth, leaded-steel bar stock. (70)

Pressed Parts. Lenape Hydraulic Pressing and Forging Co. Catalog shows numerous parts press formed by this company illustrating the kinds of jobs this firm can perform. (71)

Metal Powder Parts. Metal Powder Products, Inc., 4 pp, illus. Features a variety of applications for iron, iron-copper, and bronze sinterings made by this company. (72)

Steel Castings. Ohio Steel Foundry Co., 14 pp, illus. Illustrates the many types of castings, including carbon-steel and alloy castings, heat resistant alloy castings and stainless steel castings. (73)

Forgings. Pittsburgh Forgings Co., 8 pp, illus. No. 5201. Describes and illustrates the facilities of this company for producing drop, press and upset forgings. (74)

Powder Metal Parts. Powdered Metal Products Corp. of America. Booklet shows advantages of powder metallurgy in manufacture of such parts as gears, sprockets and valves. (75)

Investment Castings. Precision Metalsmiths, Inc. Entitled "Pour Yourself an Assembly." this booklet describes this company's facilities for casting in 160 different ferrous and nonferrous alloys. (76)

Steel Tubing. Sawhill Tubular Products, Inc., 16 pp. Information on grades and size range of company's steel tubing. (77)

Steel Castings. Steel Founders' Society of America, 4 pp, illus. Product Design Studies No. 54. Another in a series of design studies showing cost reduction and product improvement through the use of steel castings. (78)

Sheet Metal Fabrication. Stolper Steel Products Corp., 4 pp, illus, No. 2. Features case histories of sheet metal design and fabrication offered by this company. (79)

Clad Metals. Superior Steel Corp., 24 pp, illus. An introduction to clad metals offering a comprehensive survey of the manufacture and application of stainless, copper, brass and other clad steels. (80)

Bi-Metallic Construction. Arthur Tickle Engineering Works, 8 pp, illus. Description of Alumibond process for molecularly bonding aluminum and its alloys to iron and steel and their alloys. (81)

Spun Metal Parts. Roland Teiner Co., Inc., illus, No. 51D. Brochure describes this company's facilities for spinning practically any metal or gage required. (82)

Leaded Steel and Free-Cutting Brass. Titan Metal Mfg. Co., 48 pp, illus. Machinability of free-cutting brass compared with that of leaded steel. From results of research laboratory tests on two commercial metals and six-month production runs. (83)

Steel Forgings. Titusville Forge Div., Struther Wells Corp., 8 pp, illus. Describes facilities for precision forging of parts regardless of size, metal or alloy. Shows numerous parts produced. (84)

Small Precision Metal Parts. Torrington Co., 4 pp, illus. Illustrates the various small precision metal parts custom-made by the Specialties Div. of Torrington. (85)

Compression-Formed Tubing. Tube Reducing Corp., 8 pp, illus, No. R-3. Specifications, description and method of making steel compression-formed tubing included. (86)

Steel Strip. Weirton Steel Co., 20 pp, illus. Characteristics of electrolytic zinc-coated sheets and strip, high-tensile steel and high carbon strip cold-rolled spring steel being manufactured by the company. (87)

Nonferrous Metals • Parts • Forms

Die Castings. Admiral Die-Castings, Div. of Portable Electric Tools, Inc., 6 pp, illus. Folder describes company's die casting service. (88)

Die Castings. Advance Tool & Die Casting Co., 8 pp, illus. Illustrates facilities of this company to produce die castings to specifications. (89)

Aluminum Parts and Forms. Aluminum Goods Mfg. Co., illus, No. A-77. Booklet entitled "Well Prepared to Serve" gives company's facilities for producing aluminum stampings and fabrications. Lists many items being made for current defense effort. (90)

Machining Copper. American Brass Co., 32 pp, illus, No. B-3. Suggestions for machining copper, brass, bronze and nickel silver including tool rakes, clearances, cutting speeds and feeds. Tables give physical properties, constants and specifications of Anaconda metals and alloys. (91)

Pre-Finished Metals. American Nickeloid Co., 24 pp, illus. Fabrication techniques, uses and properties of pre-finished metals are described, along with case histories of applications in various manufacturing fields. (92)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 67 and 68

Precision Investment Castings. Arwood Precision Casting Corp., 16 pp, illus. Informative article on precision investment castings. Includes table of ferrous and nonferrous alloys recommended as most adaptable for this process. (93)

Precision Castings. Atlantic Castings and Engineering Corp., 12 pp, illus. "High-Quality Precision Castings for Industry" illustrates Atlantalloy casting process, gives specifications and describes all specified metals, their characteristics and uses. (94)

Vacuum Die Casting. Aurora Metal Co., 8 pp, illus. Describes process for aluminum bronze and silicon bronze. Applications, physical and chemical specifications. (95)

Metal Diaphragms. Beryllium Corp., 4 pp, illus. Helpful facts about selection of material, tooling methods, heat treating and testing procedure of beryllium copper diaphragms. (96)

Electroformed Parts. Bone Engineering Corp., 8 pp, illus. Complete data on the electroforming process offered by this company for solving complex metal forming jobs. (97)

Bronze Bar Stock and Bearings. Bunting Brass & Bronze Co., 72 pp, illus, No. 52. A complete presentation of this company's standard stock bearings, graphited oilless bearings, precision bronze bars and electric motor bearings. (98)

Brass Wire Cloth. Chase Brass & Copper Co. Lists mesh, diameter of wire, percent open area, weight and other data on complete line of company's brass and copper wire cloth. (99)

Forging. Consolidated Industries, Inc., 20 pp, illus. Discusses forging various alloys. Lists design requirements. (100)

High Alloy Castings. The Cooper Alloy Co., 4 pp, illus, No. CC54. Pictorial analysis of production stages in producing stainless steel aircraft castings. (101)

Metal Stampings. Dayton Rogers Mfg. Co., 8 pp, illus. Describes company's small lot stamping service with low die costs. (102)

Etching Aluminum Alloys. Diversey Corp., 8 pp, illus, No. 51 A. Alkaline etching compound for aluminum alloys decreases etch tank maintenance and prolongs solution life. Eliminates scale formations on tanks and coils. (103)

Forgings. Drop Forging Assn., 60 pp, illus. Data book shows mechanical qualities of forgings, and illustrates economic, engineering and production advantages. (104)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, illus, No. G137. Describes facilities for economical manufacture of quality die castings. (105)

High Density Metal. Fansteel Metallurgical Corp. Describes Fansteel 77 Metal, said to be strong, machinable, useful in rotors and balance weights, have a density close to that of tungsten. (106)

Manufacturers' Literature

Magnesium Castings. General Magnesium Foundries, Inc., 4 pp, illus. Profusely illustrates the facilities of this company for producing magnesium castings. (107)

Copper and Brass Tubing. H & H Tube & Mfg. Co. Describes a complete line of seamless braze and lock seam copper and brass tubing. (108)

Bright Nickel. Harshaw Chemical Co., 4 pp, illus. A high tolerance bright nickel process well adapted to chromium plating. (109)

Aluminum Extrusions. Harvey Aluminum Div., Harvey Machine Co., 8 pp, illus. Properties, characteristics and application of a variety of aluminum extrusions produced by this company. (110)

Investment Castings. Hitchiner Mfg. Co., 12 pp, illus. Description of precision investment castings and its advantages and limitations. (111)

Die Castings. The Hoover Co., 12 pp, illus, No. 853. Shows this company's facilities for producing zinc and aluminum die castings. Includes design helps, describes applications. (112)

Aluminum Impact Forgings. Hunter Douglas Corp., 4 pp, illus. Design suggestions for impact forgings and impact extrusions of aluminum alloy parts. (113)

Centrifugal Castings. Janney Cylinder Co., 25 pp, illus. Describes wide variety of finished machined centrifugal castings available. Lists alloys and their properties and types of products. (114)

Die Castings. Litemetal DiCast, Inc., 12 pp, illus. How to select best light metal for die casting. Shows facilities for producing light metal pressure die castings. (115)

Alloy Metals. Littleford Bros., Inc., 4 pp, illus. Facilities for fabricating large assemblies and small parts from various metal alloys. (116)

Titanium Alloys. Mallory-Sharon Titanium Corp., 4 pp, illus. Gives physical properties, forging recommendations, etc., for a high tensile strength titanium alloy primarily for bar and forging applications. (117)

Zinc and Zinc Alloys. Matthiessen & Hegeler Zinc Co., 6 pp. Physical properties and discussion of various processes that lend themselves particularly to zinc and zinc alloys. (118)

Die Castings. Monarch Aluminum Mfg. Co. File data on aluminum and zinc die castings and aluminum mold castings showing applications, advantages and this company's facilities for making them. (119)

Brass Powder Parts. New Jersey Zinc Co., 4 pp, illus. Describes applications of brass powder parts in self-developing cameras, rotors, drive bars. (120)

Die Castings. Paramount Die Castings Co., 4 pp, illus. Describes facilities and services and shows representative aluminum, magnesium and zinc castings. (121)

Spun Shapes. Phoenix Products Co., Metal Spinning Div., 4 pp, illus. Describes Phoenixspun methods for spinning spherical and extra deep-drawn contours. (122)

Machining of Titanium. Rem-Cru Titanium, Inc., 8 pp, illus, Vol. 1, No. 1. Discusses titanium machining practices and procedures recommended by customers having titanium application experience. (123)

Tubing. Trent Tube Co. Data on stainless steel and high-alloy welded tubing, engineering techniques, and tables of physical and chemical properties. (124)

Super-Alloys. Universal-Cyclops Steel Corp., 20 pp, illus. High-strength, corrosion-resistant alloys for gas turbines, turbo-superchargers, rockets and guided missiles. (125)

Nonferrous Castings. The Wellman Bronze and Aluminum Co., 16 pp, illus, No. 50. Characteristics, typical uses and specifications of Well-Cast magnesium, aluminum and copper-base alloys. (126)

Spun Tubing. Wolverine Tube Div., 28 pp, illus. Advantages and numerous applications of this firm's nonferrous Spun End Tube Process. (127)

Light Metal Forgings. Wyman-Gordon Products Corp., 4 pp, illus. Announces the availability of large-size light alloy forgings, particularly those of magnesium and 75-S aluminum. (128)

Metal Powder Parts. American Sintered Alloys Div., Yale & Towne Mfg. Co., 6 pp, illus, No. 352. Shows a variety of ferrous and nonferrous metal powder parts fabricated by this company. (129)

Nonmetallic Materials • Parts • Forms

Plastic Pipe. American Agile Corp., 12 pp. Charts give physical and mechanical properties of polyethylene and polyvinyl chloride pipe and tubing and their chemical resistance to various reagents. (130)

Plastic Pipe, Fittings and Valves. American Hard Rubber Co., 6 pp, illus, No. 80-A. Corrosion-resistant plastic pipe with good impact strength and toughness. Physical properties, chemical resistance tables and installation and fabrication data. (131)

Extruded Plastics. Anchor Plastics Co., Inc., 4 pp, illus. Covers variety of shapes, rods, strips and tubes which can be custom extruded from thermoplastics. Comparison and selection guide for ten thermoplastic materials used for extrusions. (132)

Aluminum Adhesive. Armstrong Products Co., 6 pp, illus. Features the properties of adhesive for bonding aluminum at contact pressure. (133)

Woven Glass Roving. Bigelow-Sanford Carpet Co., Inc., 2 pp. Describes mechanically bonded glass fabric used in reinforced plastics, and lists advantages. (134)

Phenolic Resins. Borden Co., Chemical Div., 8 pp, illus. Durite phenolic molding compounds, bonding resins, basing resins, and impregnating resins. (135)

Plastic Sheets. Cast Optics Corp., 12 pp. Technical properties and fabrication data of clear cast thermoset "Cocor" sheet. (137)

Thermosetting Resin. Celanese Corp. of America, Folder M-1, 6 pp. Physical properties and process characteristics of the MR series liquid low-pressure thermosetting resins for laminating, casting, coating, impregnating and molding. Folder M-2, 6 pp. Describes the Marco method for producing laminates with low-cost mating molds. (138)

Ceramic Bodies. Centralab Div., Globe Union Inc., 28 pp, illus, No. 720-10M. Comprehensive survey of this firm's ceramic production. Includes description of engineering properties of ceramics, design information, allowable tolerances, and indicates broad scope of ceramic products with data dimensions. (139)

Plastisol. Chemical Products Corp., 8 pp, illus. Chem-O-Sol plastisol formulation for industrial and consumer products. Instructions for use and several case histories of coated products. (140)

Compounded Elastomers. Chicago Rawhide Mfg. Co., 32 pp, illus. Characteristics, properties and engineering applications of Sirvene compounded elastomers. (141)

Reinforced Fiberglass Parts. Clearfield Plastics, Inc., 22 pp, illus. Discusses company's facilities for producing molded contoured parts. Suggests design and specification techniques. (142)

Thermoplastic. Colonial Plastics Mfg. Co., Industrial Div., 16 pp. Technical data on properties, available forms, fabrication and applications of Lucoflex, a rigid polyvinyl chloride. (143)

Extruded Plastic. Conneaut Rubber and Plastics Co., 4 pp, illus, No. CR-53. Die making and production facilities of rubber and plastic extrusions. (144)

Coated Fabrics. The Connecticut Hard Rubber Co. Uses, chemical, electrical and mechanical properties, and availability of heat resistant silicone rubber coated glass fabrics. (145)

Molded and Extruded Rubber. Continental Rubber Works, 8 pp, No. 100. Gives dimensions of molded and extruded rubber with cross sectional illustrations. Also condensed SAE and ASTM specification chart. (146)

Silicone. Dow Corning Corp., 2 pp, No. 10227. Fact sheets with charts describes silicone base electrical insulating varnishes and resins. (147)

Phenolic Resins. Durez Plastics & Chemicals, Inc., 6 pp, illus. Outlines uses of Durez resins, including compounded stocks, solvent-type adhesives, and use with latices. (148)

Dry Coloring Polyester Resins. Ferro Corp., 2 pp. Explains types of colors manufactured by Ferro that can be used in the dry state. (149)

Molding Compounds. Fiberite Corp., 1 p, No. 6. Lists phenolic, melamine and other resin-based molding compounds. (150)

Thermoplastic Resins. Firestone Plastics Co., Div. of Firestone Tire & Rubber Co., 20 pp, illus. Properties and use of Exon vinyl resins. Describes technical service facilities available. (151)

Laminating Materials. Flexfirm Products. A folder with 7 technical bulletins. Nos. 1, 2, 3, 111, 112, 113, 105 and fabrication instructions for polyester resin impregnated glass cloth mat supplied in dry state ready for layup. (152)

Plastic Products. General American Transportation Corp., Plastics Div., 10 pp, illus. Brochure shows plant facilities for production from blueprint through assembly and packing. Also lists wide variety of this company's molded plastics. (153)

Industrial Laminates. General Electric Co., 8 pp. How to select particular grade of laminated plastic sheet applicable to specific design problems. Charts give description, properties and applications. (154)

Shell Molding. General Electric Co., Chemical Materials Dept., 28 pp. Demonstrates shell molding process for economical production of cast parts. (155)

Vinyl Tubing. Gering Products, Inc., 4 pp, illus. Folder on Ger-Flex, a transparent, nontoxic, vinyl plastic flexible tubing with noncorrosive properties. (156)

Metallized Plastic Sheeting. Gomar Mfg. Co., Inc., 3 pp. Describes vacuum forming process and applications for metallized thermoplastic sheeting. (157)

Impervious Graphite. Graphite Specialties Corp., 4 pp, illus, No. GS 101. Impervious graphite for use at temperatures up to 5700 F in heat exchanges, crucibles, boots, nozzles, molds, etc. (158)

Plastic Coatings. R. M. Hollingshead Corp., 16 pp, illus. Manual on "cocoon" sprayable vinyl plastic coating with instructions on spraying methods. (159)

Polyester Resins. Hooker Electrochemical Co. Folder of data sheets describing fire-resistant and polyester resins. (160)

Fluorocarbon Plastics. M. W. Kellogg Co., 16 pp, illus. Index of processors and converters, manufactured items and services connected with the production of Kel-F parts and forms. (161)

Industrial Lens. Lancaster Lens Co., 4 pp, illus. Shows a variety of industrial glass products produced by this company, and lists the many industries it serves. (162)

Plastic Molding. P. R. Mallory Plastics, Inc., 4 pp, illus. Complete production facilities for large scale production of custom-molded parts from design to finishing and assembly. (163)

Glass and Ceramic Parts. Mansol Ceramics Co., 16 pp, illus. Glass preforms for hermetic seals, adhesives, steatite preform and multiform production facilities. (164)

Reinforced Wood. Met-L-Wood Corp., 15 pp, illus, No. 521. Describes combined wood and metal sheets, providing light weight and high strength. (165)

Insulating Material. Mica Insulator Co., Catalog of standard electrical insulating materials. (166)

Adhesives. Minnesota Mining & Mfg. Co., 12 pp, illus, No. 170-58. Describes uses of adhesives in aircraft manufacture. Includes a list of principal applications of adhesives in the aircraft industry. (167)

Carbon Products. Morganite Inc., 8 pp, illus, No. 1f. Specifications of various carbon bearings and bushings. Properties of six series of Morganite carbon products. (168)

Glass Bonded Mica. Mycalex Corp. of America, 24 pp, illus. Design information for parts to be machined from glass bonded mica. (169)

Nonmetallic Material. Neff-Perkins Co., 8 pp, illus, No. GC-4-54. Describes materials, products and engineering services covering a broad range of nonmetallic materials for industry. (170)

Carbon Parts. Ohio Carbon Co., 4 pp, illus. Gives thermal, mechanical and electro-mechanical properties of company's carbon parts. (171)

Nylon Tubing. Polymer Corp., 6 pp, illus. Describes 1000- and 2500-psi pressure tubing that is corrosion resistant and has wide temperature range. (172)

Carbon Graphite. Pure Carbon Co., Inc., 32 pp, ill, No. 52. Technical data on description, properties, applications and specifications of Purebon carbon graphite. (173)

Steatite Ceramic. Star Porcelain Co., 1 p, No. 600. Standard ways of insulating washers and bushing of steatite for high temperature insulation applications. (174)

Plastic Molding Presses. F. J. Stokes Machine Co., 8 pp, ill, No. 525. Describes complete line of Stokes automatic, semi-automatic, preforming and extrusion presses. (175)

Molded and Extruded Rubber Parts. Tyer Rubber Co., 8 pp, ill, No. 1P52. Detailed information on various types of molded and extruded parts of natural and synthetic rubber. (176)

Carbon and Graphite Powder. U. S. Graphite Co., 66 pp, ill. Attractively presents detailed information on Graphitar, a carbon and graphite material for seals, bearings and plates, valves, piston liners, etc. (177)

Flexible Plastic Tubing. U. S. Stoneware Co., 28 pp, illus. Gives properties and uses of extruded vinyl plastic tubing available in semi-rigid or flexible sheets, tubing or solid cord. (178)

Plastics. Westlake Plastics Co., 4 pp, illus. Properties and applications of polyethylene, polystyrene, methacrylate and fluorocarbon in sheet, rod or tube form. (179)

Sealing Design. Franklin C. Wolfe Co., Inc., 4 pp, ill. Describes facilities and products for sealing bolts, studs, rivets, flanges, etc. (180)

Finishes • Cleaning and Finishing

Aluminum Protection. American Chemical Paint Co., 4 pp. How to protect unpainted aluminum with "Alodine" No. 1200, a corrosion-resistant coating providing a durable paint bond. (181)

Blast Cleaning. Baldwin-Hill Co., 4 pp, illus. Describes mineral shot for blast cleaning that prepares metal surface in one air blast application. (182)

Cloth Belts. Behr-Manning Corp., 8 pp, ill, No. 726E. Folder features price list of complete line of Metalite cloth belts for polishing and grinding. (183)

Coated Abrasive. Carborundum Co., Coated Products Div., 8 pp, ill, No. 2. Characteristics and applications of Resin Industrial Cloth, a new coated abrasive product for dry-belt grinding. (184)

Flock. Cellusuede Products Inc., 12 pp, ill. Uses and method of application of decorator flock. Includes explanation of adhesive selection and application. (185)

Chromium Plating. Dawson Corp., ill. Folder describes packaged chromium plating plant designed for precision control of dimensional build-up or salvage of wear components, tools and gages. (186)

Descaling Process. E. I. du Pont de Nemours & Co., (Inc.) Electrochemicals Dept., 8 pp, ill, No. A-6506. Describes sodium hydride process for descaling metals, advantages and necessary equipment. (187)

Acid-Proof Coatings. Electrochemical Engineering & Mfg. Co., 8 pp, illus, No. G-53. Describes acid and alkali-proof cements as linings and coatings for floors, tanks, etc. (188)

Wear Resistant Coating. Electrolizing Corp., 16 pp. Detailed data on the Electrolizing Process for increasing the life and efficiency of metal parts subjected to wear, abrasion and corrosion. (189)

Spray Painting. Finish Engineering Co., Inc., 14 pp, ill. Equipment for masking and spray painting small parts in production volume. (190)

Flame-Plating. Linde Air Products Co., Div. of Union Carbide & Carbon Corp., 15 pp, ill. Outlines flame spray process for depositing thin coatings of tungsten carbide on metal parts for wear resistance. (191)

Colored Silicone Finishes. Midland Industrial Finishes Co., ill. Reprint interestingly discusses the application of colored silicone finishes. (192)

Coating for Zinc Surfaces. Neilson Chemical Co., No. 48-49. Describes Galvaprep, coating providing good adhesion of paint on galvanized iron, other zinc-coated surfaces. (193)

Wrinkle Finishes. New Wrinkle, Inc., ill. Folder shows typical products utilizing Wrinkle finishes. (194)

Metal Cleaners. Northwest Chemical Co., 4 pp. Chart for selecting proper cleaners for use prior to plating or organic finishing. (195)

Blast Cleaning and Dust Control. Pangborn Corp., 24 pp, ill, No. 1210. Equipment and accessories listed by equipment type and purpose. (196)

Rust Resistant Coating. Parker Rust Proof Co., 12 pp, ill. Discusses the use of Bonderite, a rust resistant coating, as an aid in cold forming. (197)

Fluorine Resin Coatings. Permolite, Inc., two 4-page bulletins. Fluor-O-Alloy coatings based in trifluorochloroethylene polymer. Includes corrosion resistance data and application data. (198)

Vapor Degreasing Equipment. Phillips

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Mfg. Co., 21 pp, ill. Handbook gives a detailed description of vapor degreasing process, the materials used, its applications, advantages and limitations. (199)

Paint Spray. Ransburg Electrocoating Corp., 16 pp, ill. Description of electrostatic spray paint process for automatic industrial applications. (200)

Metal Surface Finishing. Roto-Finish Co. 6 pp, ill. Folder describes precision finishing process and various types of machines developed for diverse job requirements. (201)

Emulsion Cleaners. Turco Products, Inc., 10 pp, ill, 106 Series Technical Sheets. Charts, uses, methods of applications, safety precautions, etc., for seven types of emulsion cleaners. (202)

Liquid Honing. Vapor Blast Mfg. Co., 4 pp, ill. Equipment for surface finishing by liquid honing, specifications and dimensions of equipment. (203)

Finishing Forgings. J. H. Williams & Co., 20 pp, ill. Describes company's facilities for all phases of forging, including cleaning and finishing. (204)

Heat Treating • Heating

Induction Furnaces. Ajax Electrothermic Corp., 8 pp, ill, No. 27A. Advantages and applications of, and equipment for induction heating and melting. Includes selector chart for induction heating and melting. (205)

Burners. American Gas Furnace Co., 48 pp, ill. Various bulletins compiled into one booklet covering the complete line of burners produced by AGF. Specifications included. (206)

Heat Treating Ovens. Carl-Mayer Corp., 6 pp, illus, No. HT-53. Brief description of various types of heat treating furnaces and ovens. (207)

Radiant Glass Panels. Corning Glass Works, 8 pp, ill, No. B-86. Uses and features of Pyrex glass panels coated with electrically conducting coating for radiant heating and drying. (208)

Conveyor Furnaces. Harper Electric Furnace Corp., 4 pp, ill, No. 454. Describes mesh belt conveyor furnaces. Gives specifications and dimensions. (209)

Furnaces. C. I. Hayes Inc., 44 pp, ill, No. 112. Complete data on a variety of furnaces for hardening, tempering, carbonitriding, forge heating, sintering, annealing and tool heat treating, as well as on atmosphere generators and ammonia dissociators (242)

Electric Heating Elements. Holcroft & Co., 4 pp, ill. Describes four types of electric heating elements and their mounting methods. Classifies heat treat furnaces according to stock handling method. (210)

Heat Treatment of Aircraft Steel. E. F. Houghton & Co., 4 pp. Explains how hardness and strength of aircraft and other steels can be developed through use of extra high-speed quenching oils such as Hought-Quench "K". (211)

Induction Heating Generators. Induction Heating Corp., 4 pp, ill. Technical data and case histories with applications of 2½- and 3½-kw induction heating generators. (212)

Carbon Control. Leeds & Northrup Co., 10 pp, ill, No. Td4-620(2) 1954. Principle and operation of automatic measurement and control of active carbon inside furnace retorts during heat treating cycles. (213)

Cold Treatment Equipment. Revco Inc., 2 pp, ill. Describes cold treating cabinets for seasoning gages and precision tools, for testing, for shrink fits, and for aircraft rivet applications. (214)

Heat Treating Equipment. Stanwood Corp., 4 pp. Brief description of types of heat treating equipment with suggested applications. (215)

Heat Treating. Stewart Industrial Furnace Div., Sunbeam Corp., 4 pp, ill. Monthly publication entitled *Metal Minutes* devoted to methods of heat treating and featuring a different installation each month. (216)

Welding • Joining

Inert Gas Welding Wire. Alloy Metal Wire Co., 4 pp, ill. A guide for stainless steel fabricators using Almet inert gas welding wire for inert gas welding, submerged arc welding and metallizing. (217)

Welding Electrode. Alloy Rods Co., 4 pp, ill, No. AR-5. Describes new electrode for welding manganese steel. (218)

Silver Brazing. American Platinum Works, 48 pp, ill. Reference manual on silver brazing discusses low temperature brazing, brazing alloys, design considerations and other topics. (219)

Welding Electrodes. Ampco Metal, Inc., 4 pp, ill, No. W-25. Characteristics and properties of bronze welding electrodes, with list of specific applications for various grades. (220)

Welding Aids. Arcos Corp., 18 pp, ill. Technical information on the welding of stainless, low alloy, high-tensile and nonferrous metals. (221)

Bolts, Nuts and Screws. Buffalo Bolt Co., Div. of Buffalo Eclipse Corp., 150 pp, ill, No. 51. Comprehensive guide for purchasing bolts, nuts and screws, includes blueprints, specifications and prices. (222)

Fastening Pins. C. E. M. Co., 4 pp, ill. Advantages and examples of how Spirol Pins overcome the inherent shortcomings of fastening pins due to their spiral cross-section. (223)

Glass Joints. Cerro de Pasco Corp., 2 pp. Instruction sheet for making glass-to-glass and glass-to-metal seals with indium and tin solder. (224)

Weldment Assemblies. Continental Foundry and Machine Tool Co., 6 pp, ill. Advantages of large welded assemblies, typical applications, and production facilities available. (225)

Paste Alloy Solders. Fusion Engineering, 4 pp, ill. Flux-containing electrical, electronic and mechanical bond paste solders and brazing alloys. (226)

Welded Assemblies. The R. C. Mahon Co., 1 p, ill. Shows several examples illustrating the capabilities of welding for construction of various assemblies. (227)

Steel Wire for Submerged Arc Welding. Metal & Thermit Corp., 4 pp, ill. Properties and composition of carbon and low alloy steel wire for welding process. (228)

Rivets. Milford Rivet & Machine Co. A handy slide rule selector gives complete rivet specifications. (229)

Screws. Russell, Burdsall & Ward Bolt & Nut Co., 8 pp, ill. Presents principle of fastening, advantages and specifications of a complete line of Spin-Lock screws available in hex, pan, truss or flat heads. (230)

Brazing Alloys. United Wire & Supply Co., 3 pp, ill. Wire brazing aluminum for low temperature brazing of various metals and alloys. (231)

Forming • Casting • Molding • Machining

Springtites and Sems. Eaton Mfg. Co., 4 pp, ill, folder C-49a. Thread cutting and self tapping springtites and sems. Dimensions. (232)

Tablet Presses. Kux Machine Co., 4 pp, ill. Tableting presses for production of powdered metal parts, ceramic parts, explosives, etc. (233)

Inspection • Testing • Control

Radium Radiography. Atomic Energy of Canada Ltd., Commercial Products Div., P. O. Box 379, Ottawa, Canada, 71 pp, ill, price $2.00. Detailed theory, equipment and applications of radium radiography. Available directly from Atomic Energy of Canada.

Nondestructive Testing Instruments. J. W. Dice Co., 8 pp, ill, No. 32. Unusual nondestructive testing instruments applicable to the automotive, aircraft, food, paper and other industries. (234)

Magnifying Contour Projector. Eastman Kodak Co., 8 pp, ill, No. FI-23. Operating principle, applications, features, specifications and accessories of this firm's contour projector. (235)

X-ray Generator. High Voltage Engineering Corp., No. JR. New model Van de Graaff one-million-volt x-ray generator for heavy duty radiography on steel thicknesses up to 4½ in. (236)

Materials Controls. Remington Rand, Inc., No. KD367. Describes Kardex system for keeping visible materials and parts inventories coordinated with production. (237)

Ultrasonic Tester. Sperry Products, Inc., 8 pp, ill, No. 50-105. Industrial applications of ultrasonic non-destructive testing techniques with the portable Sperry reflectoscope. (238)

Abrasion Resistance Tester. Taber Instrument Corp., 4 pp, illus, No. 5409. Tester evaluates resistance of surfaces to rubbing abrasion. Includes tests of painted, lacquered, electroplated surfaces and plastic coated materials. (239)

Program Controllers. Tinius Olsen Testing Machine Co., 4 pp, ill, No. 48. Describes the new line of electronic controllers for automatic production testing and research testing. (240)

General

Air Handling Equipment. The Spencer Turbine Co., No. 107-C. Data book on this company's equipment for the handling and use of compressed air. (241)

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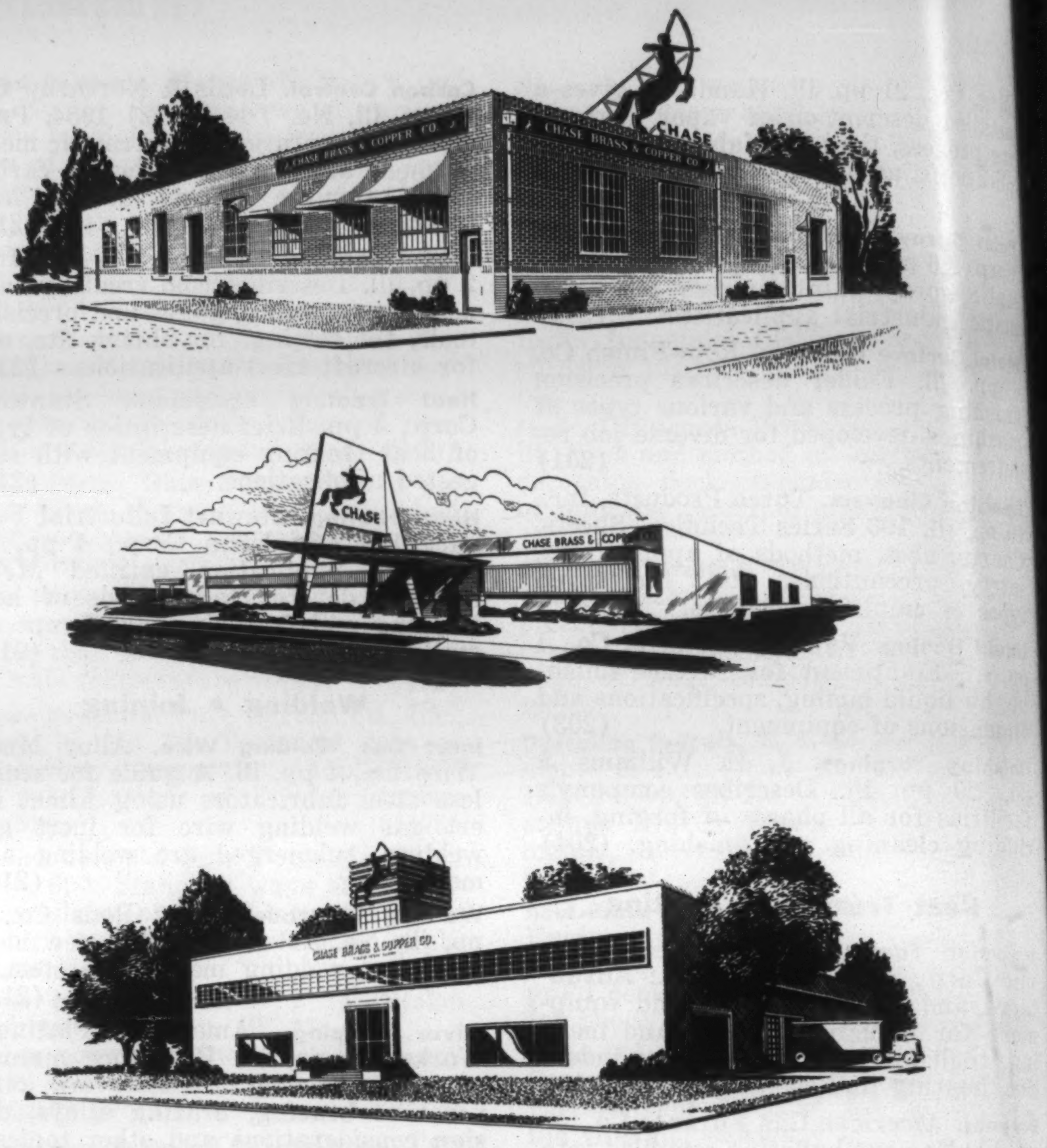
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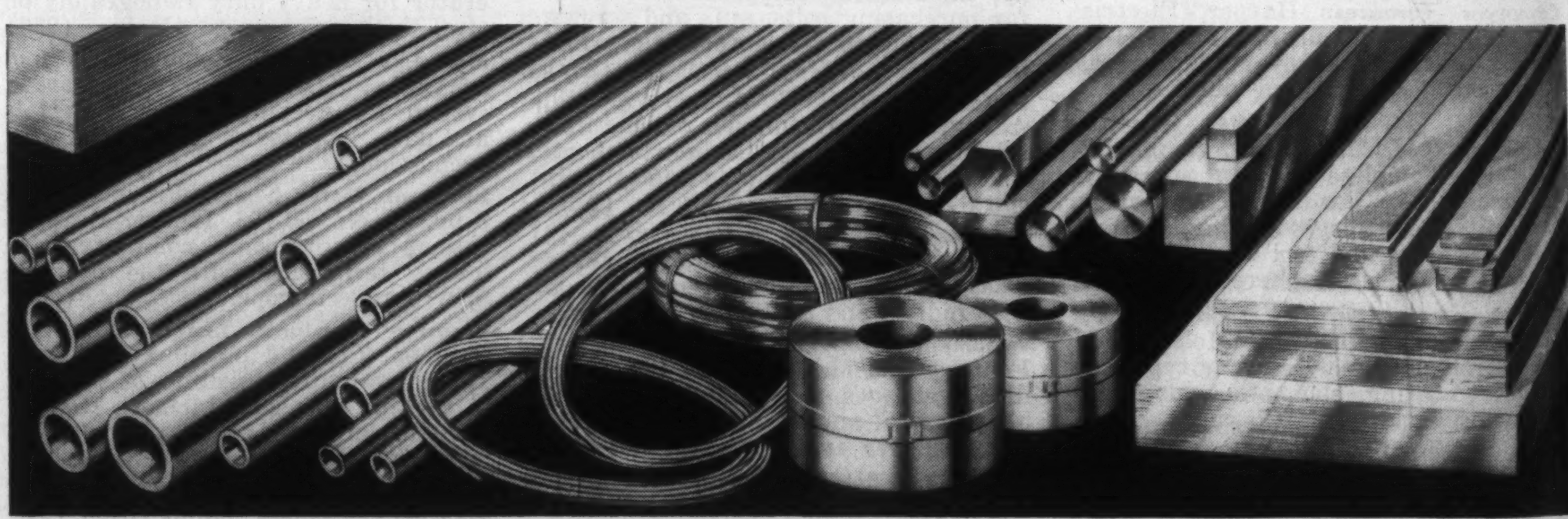

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Plastiatrics

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Testing section of Dow Plastics Coatings Laboratory.

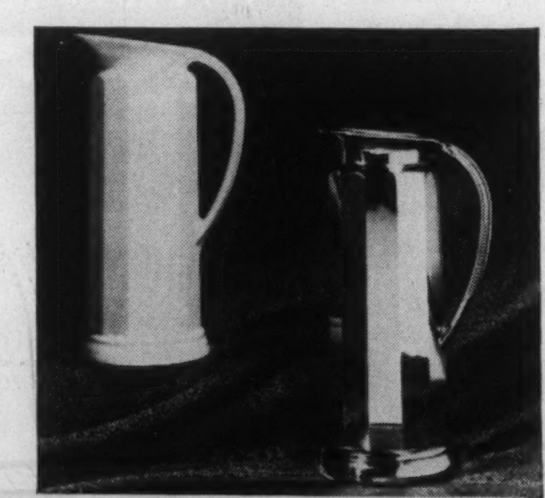
DOW STUDIES HELP YOU GET THE BEST RESULTS FROM COATINGS AND FINISHES FOR STYRON

A look at the many Styron® products on the market shows the beauty in design, wide color range and varying physical properties possible with Dow's different Styron formulations. There may be times, however, when you want to add further functional and decorative effects to Styron. Coatings and finishes can be the perfect answer if they're selected and used properly.

Dow has studied and evaluated many techniques and methods for the coating of Styron. The very *business* of Plastiatrics is to provide a continuous study, analysis and treatment of all phases of plastics and their application so that successful results can be predicted.

Which Coating or Finish Do You Use?

First, of course, you consider the results you want. Then you apply the coating that will give you that result. It is important, however, to pay careful attention to application technique. For example, lacquers are used for the striking back painting method which gives depth and gem-like appearance to escutcheons. But to be just right, the molded part should be checked for residual stress and the effect of lacquer solvent on crazing. There must be enough solvent attack to insure lasting adhesion but not enough to weaken the molding. It is important to know whether lubricants are used in the material or molding process and what effect they may have on surface adhesion. Surface treatment and application techniques can be worked out to meet specific needs. For instance, metallizing can be accomplished in any one of five different ways to provide additional physical properties or improved appearance.



An example of metallizing of Styron.

For a specialized interior finish to resemble suede, felt or mohair, a flocking process may be used. Metallizing, flocking and lacquering require many of the same basic considerations when it comes to proper application techniques. Printing and labeling to add printed words, identification, directions, etc., also pose application problems similar to lacquering, although not as critical in nature. Of course, every different type of application technique, coating, or finish requires special attention to its own problems.

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Dow studies can be of service to you because they include extensive information not only on different types of coatings and finishes but on proper application techniques, surface cleaners, drying procedures and other data. This information can help you produce results while avoiding a long trial-and-error approach that often means a costly expenditure in both time and money.

Free Bulletin Offered

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One point of view

An idea
for better
communication

During the last twenty years or so there has been considerable progress made in establishing standards for everything from the speed rating of photographic films to international screw threads. Standards have even been established for symbols used in physics, electricity and welding. As we see it, one of the important reasons for establishing standards is to make easier the communication of technical information.

In another important area, the American Society for Testing Materials has established standardized test procedures so that there will be no reason for misunderstanding exactly how the properties of materials are determined.

When one looks at what has been done, he is likely to be amazed at the progress which has been made in ending confusion. On the other hand, if he looks at what must be done, he will be stunned.

One major problem which faces us every day demands attention. We refer to the matter of terminology. By examining just one small area we can get a better understanding of why confusion still exists.

For example, take the names of metal forming methods and the resultant parts. Recently one of our MATERIALS & METHODS Manuals pointed out that despite the years press forming has been used, we still lack adequate terms to describe the various operations. For instance, what is a stamping? To some a stamping is a flat part produced on a punch press; to others a stamping is nearly any part formed on a press, including, of course, forgings.

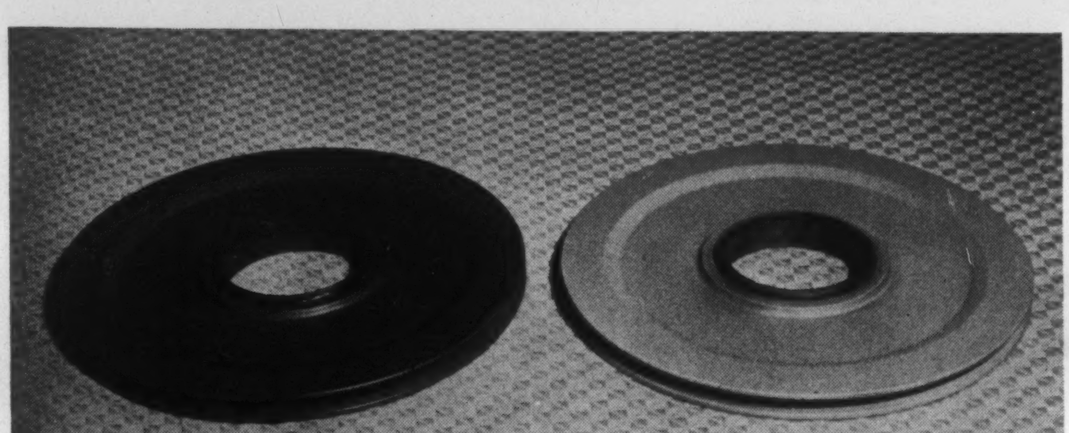
The Pressed Metal Institute is now attempting to establish satisfactory definitions, but it might run into some of the difficulties which beset the Metal Powder Association when it tried to establish a name for parts made by powder metallurgy. Some call them metal powder parts, others powder metal parts, still others, sintered metal parts. As a compromise, the term sinterings was suggested and officially adopted, but rumblings of protest negated the move. Now confusion reigns once more.

Some of the other questions which need answering are: When, if ever, does brazing become low temperature welding? What is cold forging? Just what is an impact extrusion? Many more problems exist, but these are sufficient to make the point.

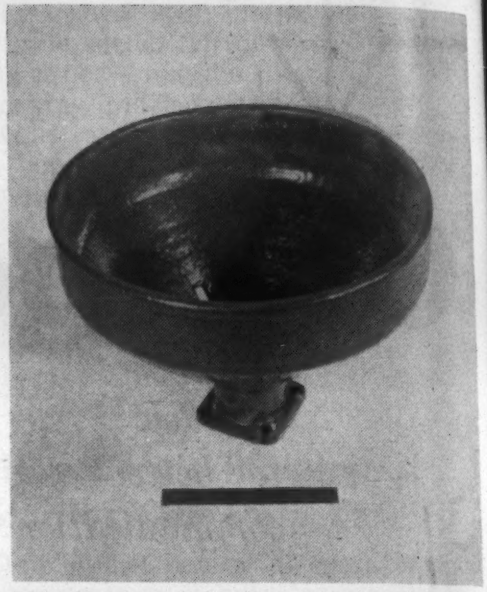
The need for clarity is becoming stronger each day as the volume of technical information multiplies. To make the information more digestible, any possibility of misunderstanding should be removed. Better terminology is one step in that direction.

T. C. Du Mond

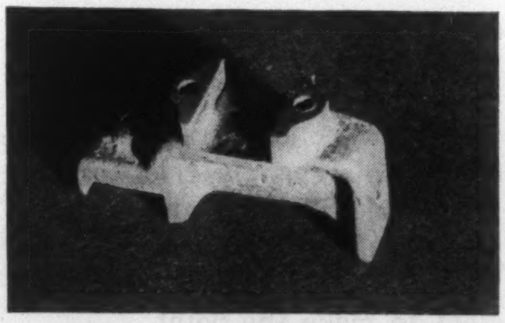
Nylon-Coated Metal Parts



Sheaves *(one on right is uncoated)*

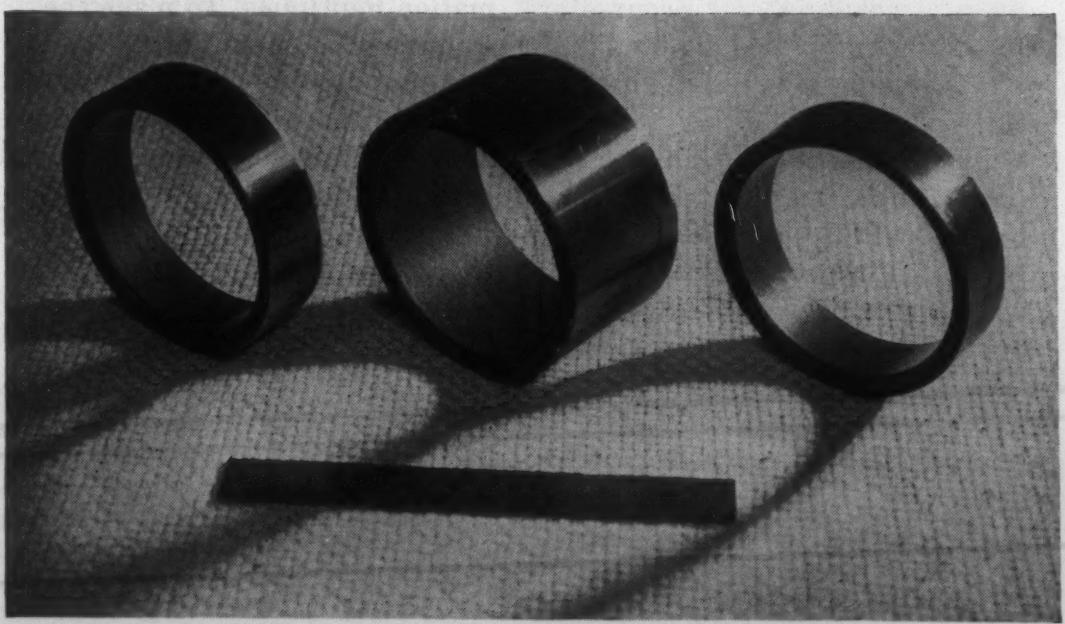


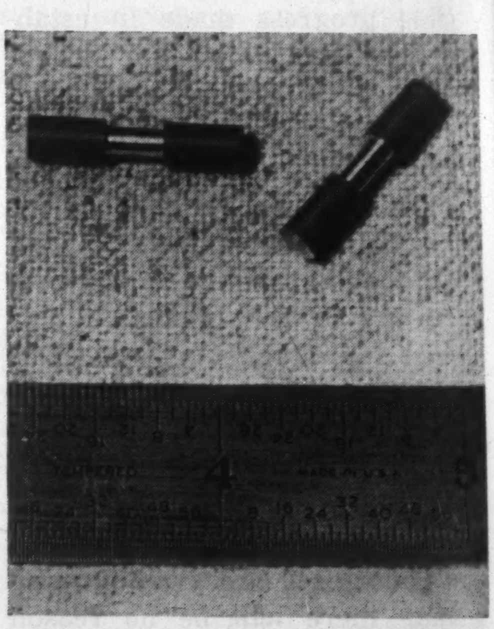
Plunger part *machined from nylon-coated aluminum rod*



Guide arm *for textile equipment*

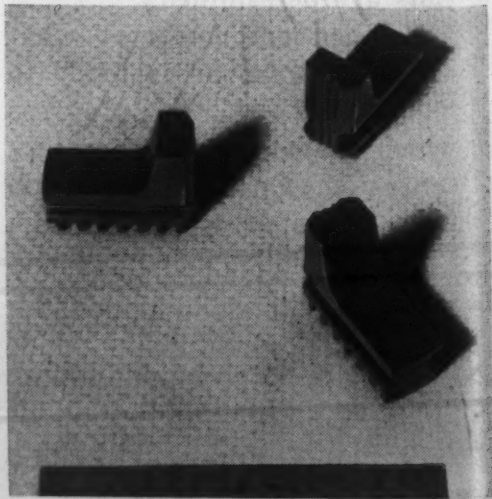
Bearings *coated on inside*





Hopper

Chuck jaws



for Wear Resistance

New coating process makes it possible to combine the good frictional characteristics of nylon with the better dimensional stability of metals.

by **Louis L. Stott,** *President, the Polymer Corp.*

■ Nylon has become more and more widely adopted for parts subjected to wear under light loads, particularly where abrasive dust is present or normal lubrication is difficult. Among the large-volume applications are rollers in refrigerator door latches, drawer rollers in file cabinets, and gears in speedometers, household food mixers and calculating machines. Most such parts are injection molded, but many industrial parts are also made from extruded or molded nylon stock shapes.

Now, development of a relatively inexpensive method for applying thin, strongly-adherent coatings of nylon to metal surfaces promises to further broaden the industrial applications of this material. The new process makes it possible to combine the desirable frictional properties of nylon with the greater strength, greater dimensional stability and lower cost of metals.

For example, the two uncoated metal surfaces of a flat plate air valve, rubbing together with good lubrication, withstood only 100,000 actuations before the valve failed from wear. An 0.005-in. coating of nylon was applied to one face of a similar valve, then ground down to 0.003 in. With one surface nylon-coated, the valve withstood more than ten times as many actuations without any lubrication at all.

Adherent coatings ranging in thickness from 0.002 to 0.030 in. have been applied to many types of steel, including stainless, and aluminum. Ceramics have also been coated successfully. Coatings on copper and copper alloys have been unsuccessful so far, but are being further investigated.

How it's done

Nylon coatings can be applied to metals in several ways, and considerable laboratory investigation has been done on the subject. The most promising method is now in a semi-pilot plant stage at the Polymer Corp., Reading, Pa.

In this process, the metal part is preheated to a certain temperature above the melting point of the nylon, then dipped into nylon which is in a specially-prepared solid form. The result is a homogenous, solvent-free coating that needs no after-bake or other hardening treatment. Correct preparation of the metal surface is an important factor. Further details of the process cannot be published at this time.

Coatings of 0.010-0.020 in. seem to be preferable for most purposes; in some cases much thinner coatings, down to 0.002-0.003 in., are desirable. Thinner coatings have better wear resistance (see accompanying graph), presumably because of better dissipation of heat.

Up to now, work has been limited to parts measuring up to 3x2x2 or 4x1x1 ft. Since the equipment is simple and relatively inexpensive, equipment for applying nylon to almost any size of metal part could be constructed.

Why a coating?

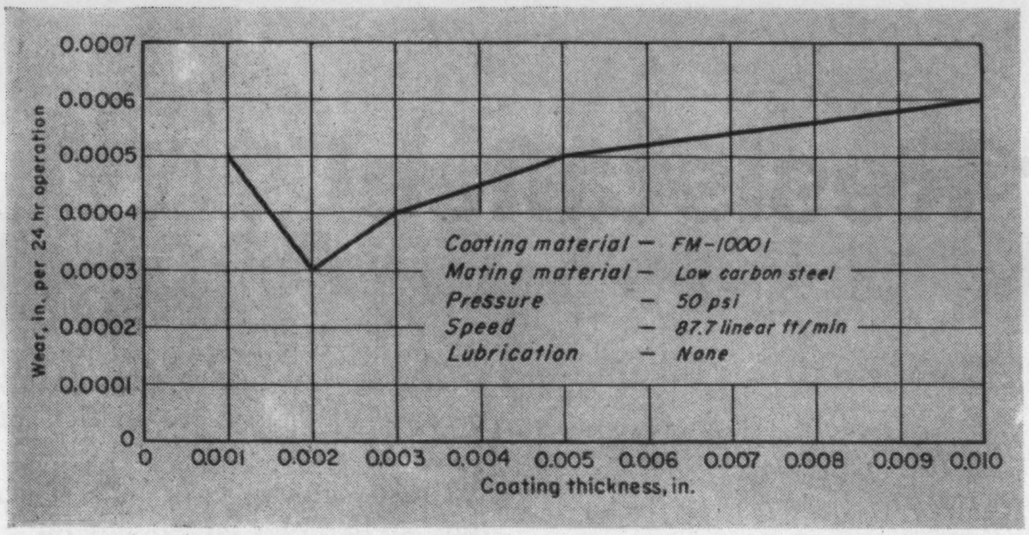
The development of nylon coatings for metals is chiefly an attempt to take full advantage of nylon's favorable frictional and wear characteristics and, at the same time, minimize the effects of its dimensional instability.

The dimensional instability of nylon in relatively large molded parts has three principal origins:

1. Hygroscopic characteristics. FM-10001 nylon expands about 0.35% for each 1% of moisture pick-up. Fortunately, nylon has good resilience and moisture pick-up in air is quite slow, particularly for massive parts. However, since even in normal-humidity environments the equilibrium moisture content is about 2½ to 3%, volumetric expansion is significant and must be recognized in proper design. It is unquestionably true that many applications for molded or machined nylon have failed not through fault of the material, but because inadequate allowance was made for normal hygroscopic expansion.

2. High thermal expansion. Nylon expands about ten times as much as steel. This fact also must be recognized in design. It is particularly important in applications such as bushings; unless a thin liner can be used, a considerably greater clearance than customary with metals is usually essential.

3. Internal stress. Small parts can be injection-molded in normal



Wear of a nylon-coated plate running against low carbon steel. Note greater wear resistance of thin coatings.

cycles without too much difficulty, but serious thermal stresses are set up when massive parts are cooled too quickly from the melt. These stresses can cause highly erratic dimensional changes, sometimes over a long period of time. Even in slowly cooled parts, the poor thermal conductivity of nylon makes it difficult to prevent variations in crystal structure upon solidification of large sections; such variations cause stresses which result in dimensional changes during subsequent machining.

A number of attempts have been made to circumvent these problems of dimensional instability. Moisture content of parts made from stock shapes can be stabilized at a predetermined level prior to final machining; the treatment consists essentially of immersing the parts in boiling water or steam. Internal stress can be largely relieved through annealing.

Thermal expansion can be reduced by addition of fillers. By proper selection of the type and quantity of filler, it is possible to improve thermal stability without too much sacrifice of nylon's desirable properties. With some fillers, such as molybdenum disulfide, it is even possible to improve the dry frictional properties of nylon.

Samples Coated

The Polymer Corp. has announced that it will coat sample quantities of metal parts and will quote on production lots. A license program is being developed to make the process available to selected firms.

A method of tackling all the dimensional instability problems simultaneously is the use of a nylon powder obtained by chemical precipitation. The powder can be readily mixed with many different types of fillers in relatively high concentration, then sintered at a temperature below the melting point to form a structure that combines nylon's excellent wear resistance with greater over-all dimensional stability (see M&M, Oct. 1952, p. 108). Such a nylon powder is now commercially available.

The most recent approach to these problems is the one described in this article—essentially to retain the surface but minimize the mass of the nylon.

Potential uses

Field evaluation tests of nylon-coated parts are underway on many types of frictional applications, including elevator gibs, cams, rollers, bushings, etc. Of special interest is the possibility of coating steel hinge pins so that open doors stay put, yet move freely under the slightest pressure; potential applications include automobile and refrigerator doors, as well as many types of household doors and cabinets.

Other possible applications:

Locking devices—Use of nylon in many types of locking devices is well-accepted. Nylon's natural resilience, strength and toughness have made possible lock nuts incorporating either a washer or a plug of nylon which effectively resists loosening under vibration. With the development of nylon coatings, it may be possible to make a simpler locking device by merely enveloping the thread of a screw itself with a resilient nylon jacket.

Gears—Nylon gears have made a definite place for themselves where silence, ability to operate without lubrication, quick starting or stopping, or very high speeds are involved. These gears are made either by injection molding to size or by cutting from blanks. Although nylon's resilience permits satisfactory performance with much wider variations in size than would ever be possible with metal gears, many tolerance problems have been encountered in the manufacture of nylon gears, particularly in molding. The possibility of coating a metal gear with nylon and achieving some of nylon's advantages warrants careful investigation.

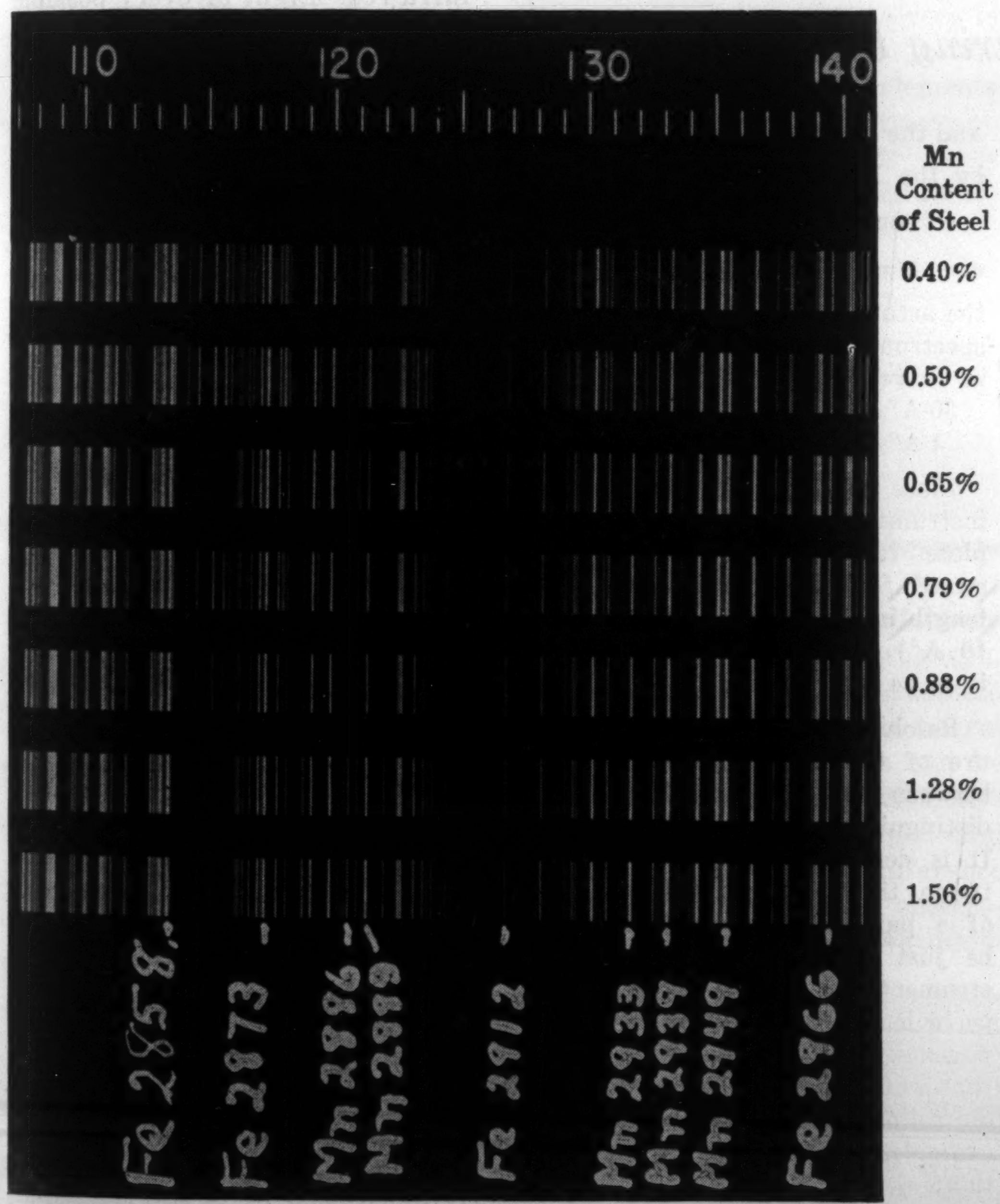
Sleeve bearings—For some years it has been recognized that a very thin layer of nylon inside a metal shell permits better dissipation of frictional heat and consequently improves bearing performance. On a commercial basis, however, it has been difficult to take advantage of this fact because of the great amount of expensive tooling needed to produce a wide range of sizes. Ability to make a bearing by merely coating the surface of a steel sleeve with a layer of nylon would provide a production flexibility that should be interesting to many manufacturers.

Nylon coatings for wear resistance seem to offer many attractive possibilities. Extensive trials are needed, however, before their industrial importance can be truly evaluated.

Where and How Spectrography Can Help You

The spectrograph is a flexible and useful tool. It has proved its worth in many metal fabricating plants for rapidly identifying and sorting alloys and for determining their composition.

by **Howard E. Boyer** and **Frank E. Fitzgerald**, *American Bosch Div.*



Spark spectrogram of iron containing varying quantities of manganese shows constant intensity of iron lines contrasted with increasing intensity of manganese lines.

■ Spectrographic methods can be used frequently to expedite metal fabrication. These methods provide an accurate means of determining the compositions of most industrial alloys and yield a permanent record of the results.

The spectrograph is flexible. It is possible to run steel, brass, aluminum and magnesium on the same plate in successive operations with little lost time, a procedure practically impossible by wet chemistry.

The spectrograph can be used also for the accurate identification and control of large quantities of metals in process including the rapid sorting of mixed materials. It has the additional advantage that one technician can replace several analytical chemists, particularly if the analyses are routine in nature.

However, the spectrograph does have limitations. Being a comparison instrument, standards are necessary and the preparation of such standards may require considerable time.

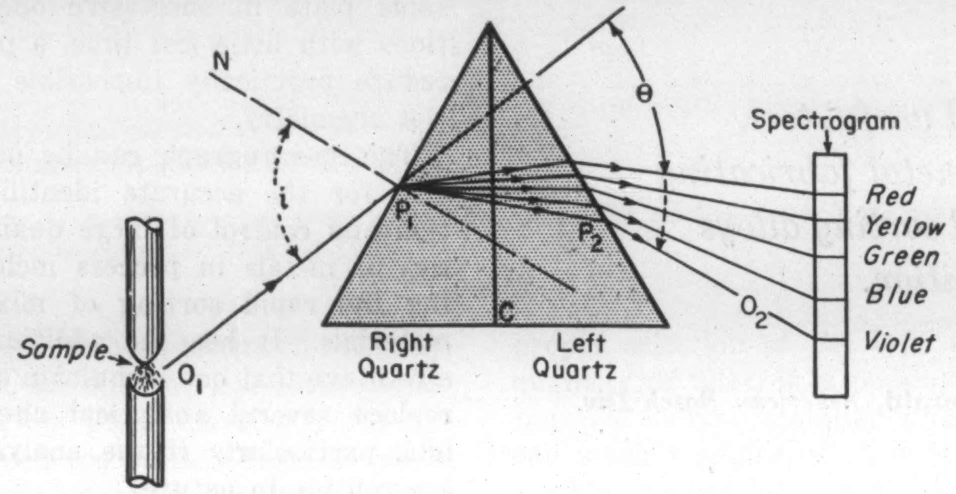
What is spectroscopy?

Although the details involved in meeting industrial requirements are somewhat complex, the basic principles of spectroscopy are simple.

Fundamentally, spectroscopy depends on the fact that each element when burned emits radiation (radiant energy) of wave lengths, characteristic of itself and differing from its neighbors by an infinitesimal amount.

When the radiation passes through a prism or grating, the characteristic wave lengths are separated into a spectrum. A spectrograph records the wave length and intensity of this spectrum on a highly sensitive photographic plate or film. Angstrom was the first worker to make accurate wave length determinations, and the unit adopted for wave length bears his name. The Angstrom is equal to 10^{-8} cm.

This article is concerned with radiation between 2000 and 10,000 Angstroms, since metals and a few of the non-metals have their sensitive lines in this region, which is accessible to the ordinary quartz spectrograph working in air. The most sensitive lines of many of the non-metals, however, are of wave lengths shorter than 2000 Angstroms. Below 1200 Angstroms the air at atmospheric pressure becomes opaque so that spectrographs for the investigation of shorter wave lengths (300A° to 2000A°) must be mounted in evacuated chambers. Lenses cannot be used, but certain metals reflect these shorter waves quite well and can be used for concave image forming gratings, even down to a few hundred Angstrom units. However, the cost of construction and expenditure of time involved in vacuum techniques preclude their use in practical analysis.



Producing and Measuring the Spectrum

Several types of spectroscopic instruments are employed for separating light waves into different colors or wave lengths. Prism and grating spectroscopes are used for practical analysis while echelons and interferometers serve for the exact measurement of light waves in research. Prisms give maximum brilliance and increasing dispersion toward the violet end of the spectrum of shorter wave lengths. Gratings give ample brilliance and equal dispersion over the entire spectrum.

Dispersion and resolving power dictate the type of spectroscope selected and it is appropriate to clarify the meaning of these terms.

Dispersion refers to spreading the lines apart. It is the ratio of the change in deviation to the change in wave length. It will be noted in the diagram of angular dispersion, that dispersion $= \frac{d\theta}{d\lambda}$ (λ = Wavelength).

Deviation depends on and varies with index while index varies with wave length. Therefore $\frac{d\theta}{d\lambda} = \frac{d\theta}{d\eta} \cdot \frac{d\eta}{d\lambda}$. The ratio $\frac{d\theta}{d\eta}$ can be determined algebraically and the second partial $\frac{d\eta}{d\lambda}$ found by the Hartman formula.

Of more practical use is linear dispersion $\frac{d\lambda}{dL}$ which gives the actual separation dL in the spectrum of two lines differing in wave length by dλ. Thus

30 A°/mm = low dispersion
1 A°/mm = high dispersion.

Since the dispersion of prism instruments is not linear, the plate factor must be determined for each narrow wave length interval (approximately 10 A°) if linear interpolation is to be used.

Resolving power is a measure of the minimum distance between two lines which will distinguish two wave lengths. It is defined as the ratio between the mean wave length of a pair of lines which can be just separated by the instrument and the difference of wave length between the components. For an instrument that would just resolve the sodium lines we would have, for example, the following resolution:

$$R = \frac{\lambda}{d\lambda} = \frac{5893}{5896\text{-}5890} = 982.$$

If we examine spectra from all sources disregarding the wavelength range involved, we invariably discover two distinct types and a third which is a combination of the two. Incandescent liquids or solids give forth *continuous radiation* in the sense that all wave lengths over a great range are present. Thus, if a spectroscope is directed toward an incandescent lamp filament, no separate slit images can be seen. There is only a continuous band of color throughout the visible range and far beyond it into the infra-red. Light of every possible gradation of wave length is present in these sources.

The other type of spectrum commonly encountered is radiation from incandescent - thermally or electrically excited gases and vapors which is characterized by having only certain definite wave lengths. For this type of radiation, the spectroscope shows *spectral lines,* each of which is an image of the spectroscope slit in each wave length present in the radiation of the gas rather than a continuous band. Such radiation passing directly from the source to the slit results in what is called an emission spectrum.

If, on the other hand, the radiation from the source is passed through a material before allowing it to fall on the slit of the spectrograph, the resulting spectrum is an absorption spectrum. Only emission spectroscopy is discussed in this article.

Advantages and uses

Although spectrographic methods have some relatively severe limitations, the advantages far outweigh the disadvantages. It is difficult to estimate the time saved by spectrographic methods compared to wet chemistry but one experienced technician using spectrographic equipment should easily perform the work of five chemists. With some alloys this ratio changes appreciably in favor of spectrography. With other simpler alloys, the ratio might shift in the other direction.

Further, the materials used for spectrographic analyses, which are principally photographic plates and chemicals for processing the plates, are simple compared with the storehouse of chemicals required for the performance of wet analyses. Although many instruments for increasing speed and accuracy have been added to the wet chemistry laboratory, these instruments represent a sizable investment which can rapidly approach the cost of spectrographic equipment.

Regardless of cost, the speed with which accurate quantitative results are obtained can be a major consideration in metal fabricating plants since the control and identification of large quantities of material is often an important factor in keeping expensive machinery busy. After production is started the question of composition must frequently be answered quickly. Spectrographic results can be obtained in a matter of minutes while hours might be required if wet chemistry methods were used. Although samples for the spectrograph require some preparation, usually facing, no more time is required than for the production of chips or drillings for wet analyses. In all probability samples can be burned and photographed easily within the time required to weigh drilling or chips. It is a simple matter to develop the plate and determine the results by means of auxiliary equipment, although naturally, the time required varies with the number of elements to be determined.

The accuracy of the spectrograph is a debatable point though the authors believe that it is more accurate than wet analysis. This is particularly true in such materials as low alloy steels where elements other than iron are relatively low in concentration. A high degree of accuracy can be obtained with materials of this nature. Stainless steels and other highly alloyed steels present problems. The accuracy in analyzing materials where 18 to 20% of an element, such as chromium or tungsten is present, is probably lower than that of the best determinations by wet chemistry. For the most part, however, methods have been developed which are sufficiently accurate for practical purposes. Another distinct advantage of spectrographic analyses is the fact that in addition to the elements sought, trace elements appear on the same spectrogram. Since practically all alloy steels are now contaminated to some degree with trace elements, knowledge of their presence is often necessary. For example, the hardenability of alloy steels can be influenced markedly by trace elements.

Spectrographic methods are also extremely useful in cases where a mixup of material is suspected. It is difficult to analyze quickly 50 or 100 bars of steel by wet chemistry but this is relatively simple with the spectrograph. Although one or two complete quantitative analyses may be required, most of the bars can be sorted by semi-quantitative analysis, which is far cheaper and faster. If a marked difference appears in one of the spectrograms, another quantitative analysis can be made to establish the identity of the particular sample.

Some Definitions

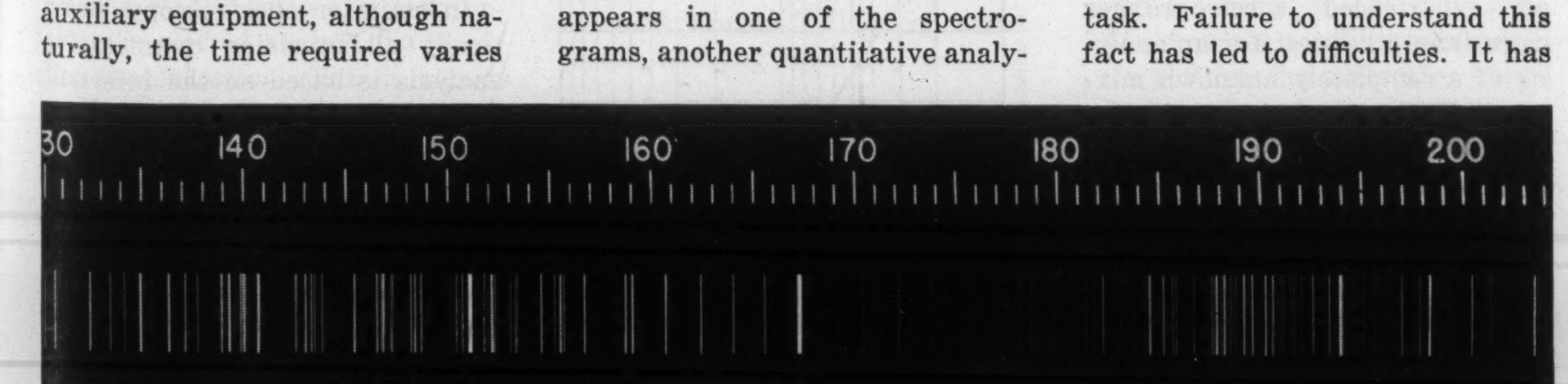
Any instrument that can be used to produce a spectrum, visible or invisible is called a *spectroscope*. In the more restricted sense, however, the word spectroscope designates an instrument, arranged so that the spectrum can be seen, providing the spectrum remains in the visible eye.

For extension beyond the visible range, a spectrograph is used. This instrument records the spectrum on a photographic plate or film, using an emulsion sensitive to lines whose intensity is not sufficient to produce a visual effect. This recording is called a *spectrogram.*

Another advantage of the spectrograph is the ability to obtain complete and accurate analyses without necessarily destroying valuable parts. Any casting or forging which can be faced to obtain clean metal in a flat plane and supported upon the spectrographich stand can be analyzed. One or two slightly burned spots will appear but otherwise the casting or forging is usually suitable for use. This can reflect large savings since wet chemistry methods may involve destruction of the part.

Limitations

Although the spectrograph is a useful tool in the metallurgical laboratory, it has definite limitations. The installation of spectrography in any plant is no simple task. Failure to understand this fact has led to difficulties. It has



Spectrum of Iron in the ultraviolet region using arc excitation. Spacing of the lines is characteristic only of iron.

often been assumed that the equipment is complete in itself and can be installed and immediately put into full scale operation. Nothing is further from the truth. A new installation regardless of make or type requires many hours of tedious work by an experienced technician before worthwhile results are obtained.

In the first place, no quantitative analyses can be performed without using known materials as standards since the spectrograph is a comparator. The process is dependent on results obtained previously by wet chemical analysis. However, once these standards are obtained they will serve indefinitely. Another serious limitation is the fact that not all elements can be determined by spectrographic methods, although approximately seventy-six elements will show suitable spectral lines.

For copper-, aluminum- and magnesium-base alloys the work can usually be completed by the spectrograph. For steel and other iron base alloys this is not the case. Carbon, the key alloying element in steel, cannot be determined on a practical basis by spectrographic methods. However, a great deal of experimental work has been done in this direction and no doubt this important element will soon be determined accurately by quantitative spectrographic analysis. A few other elements fall into this category, but the spectrograph covers most elements encountered in the metal working industry.

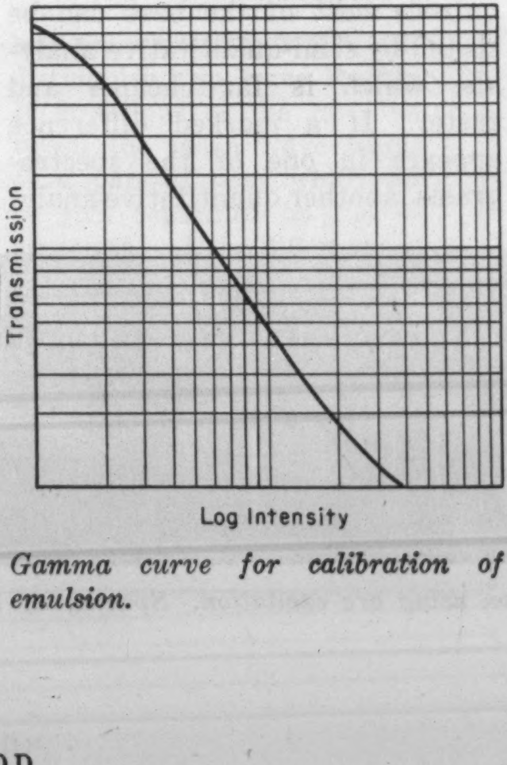
It has been difficult also to dispel the idea that, having the apparatus at hand, it is a simple matter to analyze almost anything quantitatively. Nothing annoys an experienced spectrographer more than a request for an analysis of a completely unknown mixture. Without semi-quantitative standards it is simply a matter of guesswork, since allowance has to be made for matrix effects such as "line suppression" or "line enhancement", and even then an estimate may be off as much as a factor of ten.

However, with proper standards a fair semi-quantitative estimate may be within 30% of the truth. Greater accuracy cannot be achieved without constructing "working curves" thus making it a major project. It should be thoroughly understood that a working curve usually covers a rather specific condition. Thus, a curve suitable for determining the percentage of nickel in steel is of no value in determining a similar percentage of nickel in a copper base alloy. Furthermore, different working curves must be used in many cases for different concentration ranges of an element, even though the internal standard is the same. For example, a curve or line-pair which accomodates a range of 0 to 1% of a certain element might not lend itself to a condition where 3% of the same element is present.

Four degrees of accuracy

Spectrochemical analysis can be divided into four classifications of accuracy; qualitative, qualitative with quantitative estimates, semi-quantitative and quantitative.

The term "qualitative" implies only positive identification without indicating whether the element is a trace or a major constituent. Such analysis is of little value for the metal fabricating plant. However, the term qualitative with quantitative estimates is a visual method of deriving percentages from an examination of the persistent and secondary lines. Persistent lines are those detectable at the lowest concentration of the atom at which lines appear. Secondary lines are lines which originate at high levels of excitation and represent transitions into lower levels but not the unexcited level.



Gamma curve for calibration of emulsion.

Semi-quantitative analysis, although more accurate than qualitative analysis, is less accurate than exact quantitative procedure. It is useful when the information desired does not justify the work involved in setting up a quantitative procedure. Basically similar to qualitative analysis, it differs in using a weighed sample which is completely vaporized. Selected lines are evaluated densitometrically against background as an internal standard. This line-to-background intensity ratio is multiplied by a sensitivity factor for the particular spectrum line in that matrix material.

Quantitative spectrochemical analysis is based on the fact that the spectral lines of an element decrease in intensity in a definite order with decreasing concentration while their intensities at any concentration are simple functions of the concentration. The influence of concentration on the strength of the spectrum lines for a substance present in small amounts is shown in a series of iron spectra. Although the spectra of iron containing varying percentages of manganese were made under identical conditions as shown by the uniform intensity of the marked iron lines, the manganese lines decrease in intensity with decreasing concentration. The actual concentration of manganese represented by the individual intensities is determined by comparison with standards.

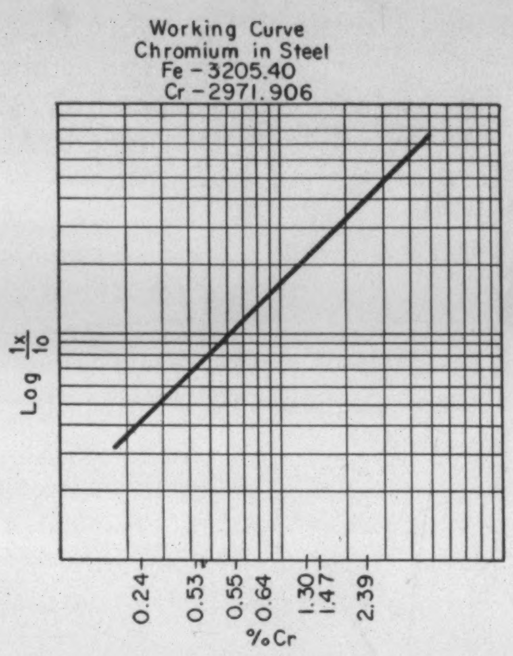
In emission spectroscopy, practically all precision quantitative analysis is based on the internal-standard principle because variations in current and voltage seem unavoidable in both arc and spark and the reproducibility of excitation cannot be accurately controlled from one analysis to the next. Comparison is made between a line of the element being estimated and a line of another element present in known amount.

This procedure should result in a constant ratio of the intensities of the two lines. In practice the internal standard is one of the lines of the major constituent of the alloy which is known to be present in fixed concentration such as iron in steel. In brass, either copper or zinc can be chosen as an internal standard. The fact that a sample contains a smaller percentage of zinc than of copper does not prevent the use of zinc as the internal standard.

For quantitative analysis the spectroscopist needs a series of samples containing varying known amounts of the element for which the analysis is to be made. The choice of a sample depends largely on the nature of the product to be investigated. If an alloy is to be analyzed, standard samples should be prepared from a similar alloy base. If a refractory material is to be analyzed, the base composition should be a refractory.

This discussion deals with alloys in solid form and is limited to the point-to-plane technique used for wrought or cast alloys. After milling to a smooth surface, the standards are excited on an arc or spark stand and the spectra recorded on a photographic plate. The densities of a suitable line pair are determined on the densitometer. Since the density of the matrix line in fixed concentration will vary under different conditions in the same manner as the density of the element line, the ratio of these two densities known to unknown will remain reasonably constant. Using the calibration curve these density readings are converted to intensities and the log of the ratio of the intensities is plotted against the log of the concentration. This is known as the working curve.

The construction of suitable working curves can be a long and tedious procedure. In some organizations only a few working curves may be required while in other plants dozens or perhaps even hundreds of working curves are essential to handling a wide variety of alloys.



Working curve for the determination of chromium in steel.

Having established working curves for various elements in an alloy, the system is ready for routine analysis. Samples of unknown concentration are excited in exactly the same way as standard samples. After development, the plate is read for the same line pairs on the densitometer. Once the ratio of intensities is determined from the calibration curve, the working curve will give the concentration of the element to be determined.

However, slight variations occur in excitation from day to day and human error is involved in densitometer readings. Therefore, a group of typical working standards with known concentrations of the various elements is kept on hand. For the analysis of a group of chromium-nickel alloy steels, a typical working standard might be SAE-9317. Running a working standard before the group of unknown samples serves to check the drift that can occur in the working curve.

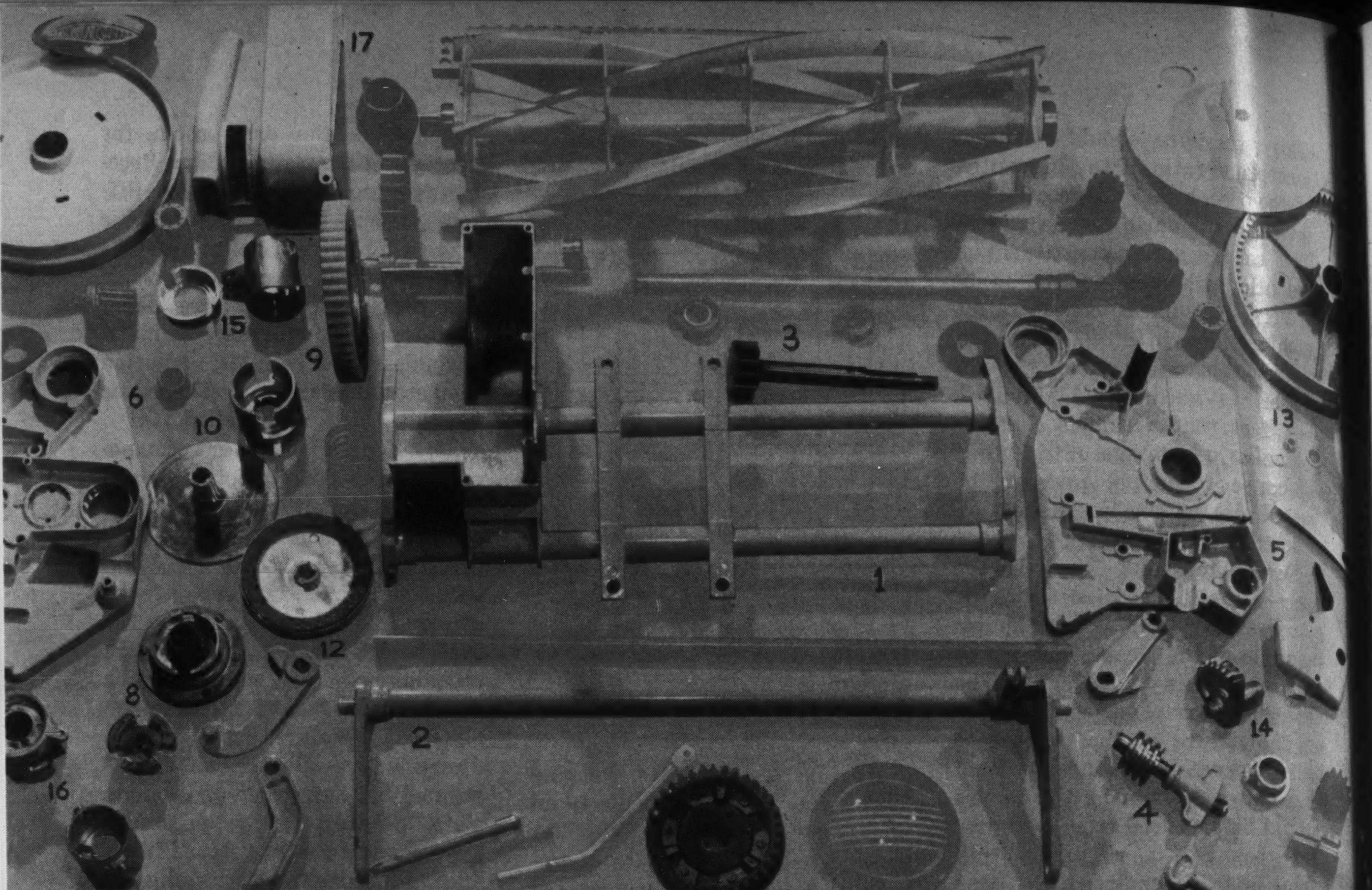
Equipment

Spectrographic analytical equipment usually consists of four major components. First, is the prism or grating spectrograph (see description in box). Next is the power source or type of specimen excitation. The third, comprising a group of smaller components, is the dark room for processing the plates or film. Processing spectrographic plates differs from other photographic processing only in degree of control required, especially when quantitative analyses are being performed. To eliminate as many variables as possible, solution temperature and processing time must be closely controlled.

The fourth important component is the densitometer, an instrument for the identification and measurement of photographed spectra. The length of the spectral lines, or the height of the spectrogram which appears on the processed plate is arbitrary. In the interest of economy, the camera is arranged so that the plate can be moved in a vertical direction thus allowing many exposures to be recorded on a single plate. Therefore, the processed plate shows rows of vertical black lines. Identification is usually accomplished by comparing the spectrogram with a wave length scale or calibrated plate. This plate includes an iron spectrum for alignment of the sample spectrogram with the wave length scale, a series of short lines to indicate ten Angstrom divisions, and a series of long lines keyed with a dot and a chemical symbol at the position in the spectrum of the persistent lines of the various elements. Use of this plate permits the analyst to determine which elements are present and to select suitable lines for quantitative work.

After the density of selected lines has been determined, a calculating board is used to translate experimentally determined photographic blackening values into light intensity of the discharge. This requires a calibration curve.

In plotting the calibration curve, which is the relationship between the intensity of light reaching a film and the resultant photochemical response of the emulsion, the ordinate is usually a measure of film blackening expressed in terms of density, galvanometer deflection, or transmission. The abscissa is a measure of the exposure or relative intensity.



Die castings *(high-lighted in photo) form bulk of mower. Those discussed in text are numbered.*

These Die Castings Cut Weight of

Latest die casting techniques used to gain optimum properties and efficient design.

by **Albert G. Lintel,** *Vice President, Precision Castings Co.*

■ Selective use of die castings has been instrumental in reducing unit cost, increasing freedom of design and lowering weight of a power lawn mower manufactured by Clemson Bros. of Middletown, N. Y.

Most of the major components of the machine are now zinc die castings. Though initial cost of the 27 dies needed to produce the 35 castings was high, on a unit basis it has been more than offset by quantity production and manufacturing advantages resulting from the precision inherent in the casting process. Allowing the die caster to redesign specifically for the process, permitted full utilization of up-to-date die casting techniques to gain the optimum in mechanical properties of the materials. The end result is a less expensive, more integrated and attractive unit weighing only 53 lb.

The parts discussed here illustrate how modern die casting techniques can be used effectively to facilitate design and manufacture of a product. All parts are of Zamack 5 except those specifically designated as Mn-4, a high manganese zinc alloy.

Inserts aid integration

The ability to cast inserts integrally with the die casting eliminates assembly operations, increases rigidity and reduces the number of separate components which must finally be assembled. Rigidity of the main mower frame (1) is obtained by casting in one "shot" two hollow steel tube inserts, the engine mounting, side-frame flange and gear case with side flange. The steel tube inserts are knurled in areas of contact with cast metal to provide greater holding power, and caps over the tube ends prevent leakage of molten metal during casting. The steel tube insert in the yoke (2) is also knurled and capped before casting pivot mountings on the ends for the mower handle extension.

The pinion gear (3) of Mn-4 alloy is die-cast on the counter shaft which is made of bar steel and knurled and grooved in contact areas. The Zn-5 worm gear (4) is die cast in a like manner on bar steel, and both right and left side frames (5 and 6) have steel rod inserts. Wall thickness in the frame is 0.093 in.

Gears, clutches and cams

Since no sprocket, chain or V-belt drives are used in the mower, two gear trains are required to provide propulsion and free-wheeling characteristics. The gears and clutches require careful design and construction since they are designed to absorb operational shock and torque load. The power take-off consists of a 3-gear unit. A powder metal pinion engages the die-cast Mn-4 reel clutch gear (7), to which are riveted steel cam lugs. The lugs mate with similar cam surfaces riveted to the Zn-5 die cast driven member (8) to provide disengaging action in case the reel or "flying knives" strikes an obstruction during operation. The Zn-5 reel clutch-driven disk (12) with a cork face is carried by the counter shaft and constitutes a backing for the thrust of the clutch gear when clutch is engaged.

The reel clutch gear meshes with a nylon propulsion clutch gear (9). The nylon gear consists of a die cast center section to which is riveted a nylon gear ring. Inside the nylon ring and cemented to the face of the center section is a cork face which mates with a die-cast clutch disk (10). In this 3-gear train — powder metal motor pinion meshing with die cast clutch gear, in turn meshing with nylon propulsion clutch gear—materials selection was based on the need to minimize lubrication.

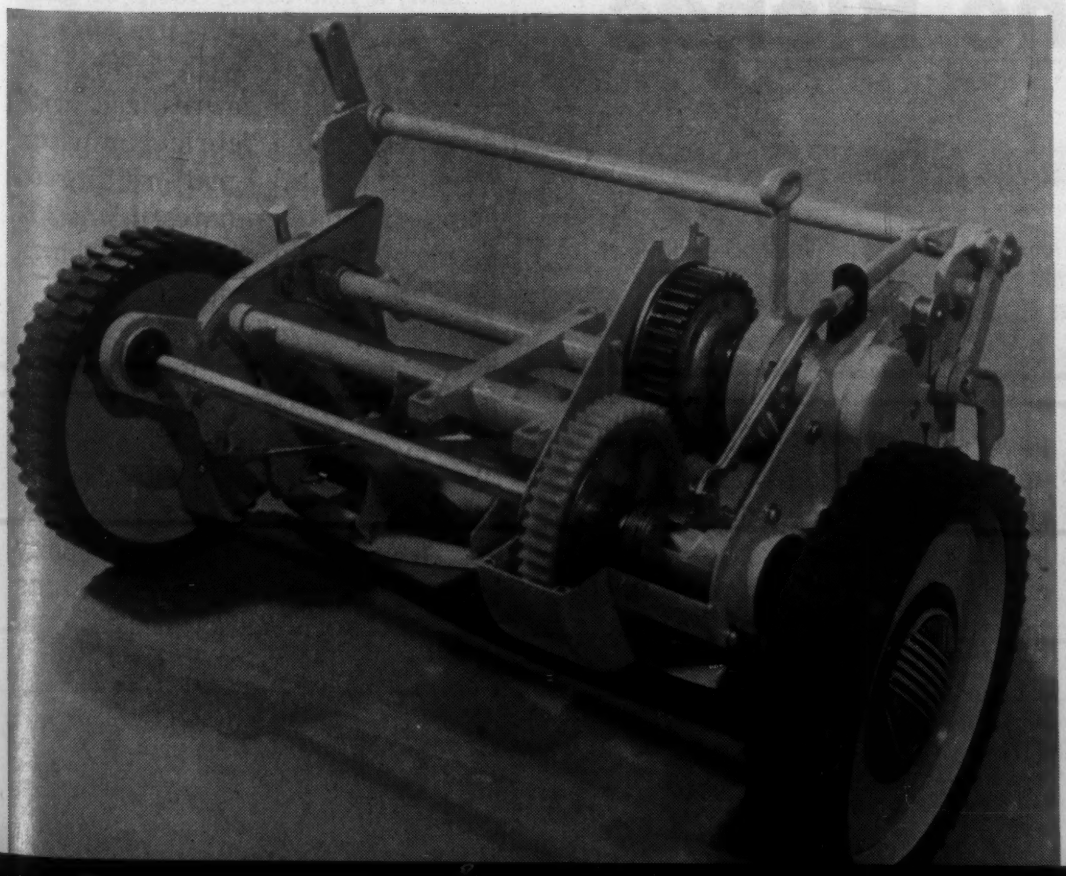
The reel drive unit consists of four gears. Two idler gears are of powder metal for good lubricating and bearing characteristics. Meshing with the powder metal gears are two Mn-4 die cast gears, one cast on the counter shaft (3), the other, on the lower end of the gear train, is the reel gear (11) with a cored irregular shaped hole in the center. Another gear (13), is die cast on the internal periphery of the ground wheel and meshes with the steel pinion on end of propulsion shaft. Teeth on the worm gear sector (14) are cast to conform with the helix angle of the worm gear (4).

Connected to the clutch disk (10) is the spring shell unit (15 and 16) which engages and disengages the cork-faced nylon propulsion gear, providing the mower with free wheeling. Tolerances of ±0.002 in. are held on die cast cam surfaces and as-cast dimensional accuracy permits the manufacturer to press-in a bearing cup without additional reaming or boring.

Other parts shown comprise the balance of die castings used in the mower. The gear case cover (7) is a good example of a part with curved surfaces where an accurate fit was necessary, while maintaining a wall thickness of 0.060 in.

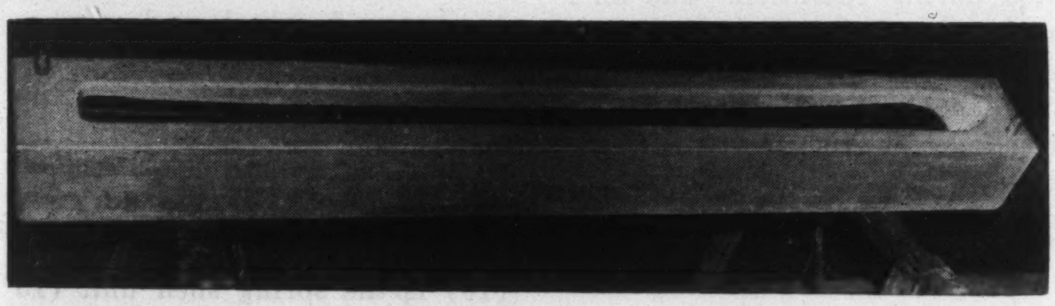
Dies with intricate gating and venting can be built most economically by cooperating at the design level with the die casting engineer.

Power Mower



EPOXY—FURANE
CORROSION RESISTANT SINK

High chemical resistance *of epoxy resins is not reduced by blending with furane resins.*



Blending furane with epoxies *permits the production of such items as glass-reinforced skis at an appreciably lower cost than that of straight epoxy-glass laminates.*

Epoxy-Furane Blends

- *Cut cost of epoxy laminates*
- *Compare favorably with straight epoxies*

by **Dr. W. Brenner,** *Chief Chemist and* **E. J. Singer,** *Plastics Engineer, East Coast Aeronautics, Inc.*

■ The high cost of epoxy resins has somewhat limited their use in structural laminates in spite of their high mechanical properties, good chemical resistance, good laminating characteristics, and low shrinkage. The cost of raw materials has now been materially reduced by the development of an epoxy-furane resin blend which has physical properties comparable to those of conventional epoxies.

Epoxy resins cost about 80 cents per lb which is almost 2.5 times the cost of general purpose polyesters. By blending as much as 40% of a furfural-ketone resin with epoxy, the cost can be reduced to less than 65 cents per lb, while maintaining physical properties in resulting laminates exceeding those required by the commonly used specification MIL-P-8013. Epoxy-furane laminates also exhibit superior chemical resistance, primarily to acids, in comparison with many conventional epoxy systems. Though contact pressure is sufficient to assure good cures, optimum properties are realized with moderate pressure. Use of contact pressures frees the designer from limitations imposed by press size.

Properties of laminates

Test results on glass cloth-reinforced epoxy-furane laminates (Table 1) indicate that additions of furane resins in amounts up to and including 40% by weight produce laminates with strength properties exceeding those required by commonly employed government specifications. The 20% furane laminates are superior in compressive and tensile properties to applicable low pressure standards but prove slightly deficient in tensile strength characteristics. Table 2 lists typical properties of epoxy-furane laminates with essentially unidirectional reinforcement.

Mat, a less costly form of glass reinforcement, can be used to produce laminates with properties approaching those realized with more expensive fabric laminates. Properties of mat-reinforced epoxy-furane laminates using 3% of a thixotropic agent are shown in Table 3 in comparison with specifications listed under MIL-P-8013. Results of limited experimental work indicate that a 30 hr exposure of a typical laminate to 350 F decreases flexural strength at room temperature by as little as 20%. Many straight epoxy systems experience a drop of as much as 60% upon similar heat exposure.

Chemical resistance of low pressure laminates is important for potential industrial applications involving transportation and storage of chemicals. Data tabulated in Table 5 suggest that epoxy-furane laminates have a chemical resistance of at least the same order as that of conventional epoxy resins.

In order to obtain higher impact strength and an increased degree of flexibility, epoxy-furane laminates may be modified by addition of Thiokol polysulfide polymers. Impact strength of resulting laminates is comparable to that of conventional epoxy-Thiokol systems and exceeds 30 ft-lb per in. of notch Izod for representative formulations. There is, of course, some decrease in physical strength as shown in Table 6. However, the laminates exhibit exceptional toughness, resistance to thermal cycling and porosity development under pressure application. Leak level of a

What are furanes?

Furfural chemicals are derived from agricultural residues such as corn cobs which are in plentiful supply. Their price structure is stable and low. While furfural resins are most commonly manufactured from furfural alcohol and furfuraldehyde—phenol condensation products—materials found most suitable for blending with epoxide resins are of the furfural-ketone type. Furfural-ketone polymers are readily manufactured from low cost raw materials and are commercially available. They have previously found considerable utility in the formulation of adhesives and casting compounds. The furfural-ketone resin used in blends described in this article is Furatone 1949. The epoxy used is Epon 828, though others such as BRR 18774 and 18794 or Araldite 6010 and 6020 are satisfactory.

TABLE 1—EFFECT OF PERCENTAGE OF FURANE RESIN ON LAMINATE STRENGTH[a]

% Furane in Mix	% Resin in Laminate	Flexural Strength, psi and Modulus, psi x 10⁶				Compressive Strength, psi		Tensile Strength, psi	
		Dry		Wet		Dry	Wet	Dry	Wet
0 (Straight epoxy)	29	71,200	2.91	70,020	2.79	48,300	47,250	52,100	——
15	28	76,740	3.38	78,460	3.22	54,480	49,560	56,220	57,920
20	30	88,490	3.84	86,110	3.71	53,370	——	60,525	——
25	32	79,930	3.57	——	——	44,550	35,550	57,150	58,950
30	29	75,000	3.50	——	——	41,630	——	54,810	——
40 (Slow cure)	27	74,800	3.38	66,000	3.25	41,900	39,100	53,060	——
60 (Slow cure)	28	45,600	3.28	——	——	40,100	——	48,110	——
(MIL-P-8013)		50,000	2.7	45,000	2.5	35,000	30,000	40,000	38,000

[a] *Laminates prepared with 181 Volan A glass cloth; ⅛ in. thick, cured at 300 F approximately 60 min.*

TABLE 2—PHYSICAL PROPERTIES OF 80-20 EPOXY-FURANE LAMINATE WITH UNIDIRECTIONAL REINFORCEMENT[a]

Resin Content %	Flexural Strength, psi and Modulus, psi x 10⁶				Compressive Strength, psi and Modulus, psi x 10⁶				Tensile Strength, psi and Modulus, psi x 10⁶			
	Dry		Wet		Dry		Wet		Dry		Wet	
32	112,090	5.17	97,670	5.06	64,220	4.86	48,040	4.95	72,360	5.21	72,530	5.10
MIL-P-8013	90,000	4.7	78,000	4.5	48,000	—	43,000	—	80,000	—	75,000	—

[a] *Laminate prepared with 143 Volan A glass cloth*

TABLE 3—PHYSICAL PROPERTIES OF EPOXY-FURANE MAT LAMINATES[a]

% Furane	Total Resin Content	Flexural Strength, psi and Modulus, psi x 10⁶				Compressive Strength, psi and Modulus, psi x 10⁶				Tensile Strength, psi and Modulus, psi x 10⁶			
		Dry		Wet		Dry		Wet		Dry		Wet	
20	52	43,160	1.59	36,820	1.42	30,090	1.39	21,900	1.22	19,090	1.16	17,140	1.01
40	47	32,810	1.28	28,470	1.25	22,280	1.42	18,470	1.21	17,550	1.22	18,750	1.18
MIL-P-8013		25,000	1.40	20,000	1.20	20,000	—	18,000	—	20,000	—	18,000	—

[a] *1½-oz. Ferro mat, Garan finish*

TABLE 4—EFFECT OF HEAT EXPOSURE ON FLEXURAL STRENGTH OF 80-20 EPOXY-FURANE LAMINATES[a]

Heat Exposure 350 F, hr	Flexural Strength, psi At Room Temperature	Flexural Modulus At Room Temperature, psi x 10⁶
3	81,060	3.75
6	73,080	3.40
15	72,950	3.40
30	71,630	3.33

[a] *181 Volan A glass cloth*

TABLE 5—CHEMICAL RESISTANCE OF 60-40 EPOXY-FURANE LAMINATES[a]

Reagent	% Change in Wt Epoxy-Furane	% Change in Wt Epoxy
Acetone	−0.25	+0.29
Conc. Ammonia	None	None
50% Sodium Hydroxide	None	+0.01
Sodium Dichromate Solution	−0.14	−0.17
Nitric Acid 10%	+1.0	+1.3
Sulfuric Acid 10%	+0.05	+0.10
Phosphoric Acid 10%	+0.05	+0.15
Hydrochloric Acid 37%	+0.02	+0.05
Hydrofluoric Acid 10%	+5.0	Disintegrates
Hydrofluoric Acid 50%	+45.0	Disintegrates
Tap Water	0.51	0.60
Jet Fuel	0.02	0.02

[a] *7-day immersion at room temperature for ⅛ in. thick, 181 cloth laminates*

typical 60 epoxy-40 furane-5% Thiokol cylindrical structure with a 2 in. i.d. exceeds an internal pressure of more than 3000 psi.

Compounding and curing

While a variety of amine curing agents have been useful in hardening epoxy-furane resin blends, metaphenylene diamine (Shell Curing Agent CL) has proved to be particularly effective with heat cures. Strength properties of resulting laminates are greatly affected by changes in amount of catalyst used. Optimum concentration of metaphenylene diamine appears to be 15% by weight of resins. All data presented here were obtained from CL cured systems. Other catalysts which have provided satisfactory cures include triethylene tetramine piperidine and diethylamine-propylamine.

Pot life of amine catalyzed epoxy-furane systems is greater than that of conventional epoxies. Length of pot life, of course is dependent on such factors as size, shape, section thickness and temperature. Experiments indicate that a 20% increase in pot life can generally be expected for laminates compared to many analogous straight epoxy systems.

Addition of furfural-ketone to epoxy resins always results in a substantial decrease in viscosity of the blend. Though this is desirable for casting and laminating work, it presents a problem of excessive flow-out of resin, especially upon application of pressure. To overcome this problem thixotropic materials such as silica aerogels, metallic soap derivatives, etc., may be added to the resin blend. Use of higher pressures requires larger additions of such thixotropes. Precure periods at contact pressure perform a similar function.

Where very low viscosities such as 600 cps are desired, 3% xylene has been added without affecting laminate properties unfavorably. This is particularly important where filled blends are desired. Satisfactory fillers include calcium carbonates, clays, mica, asbestos, etc., in amounts ranging up to 10 parts by wt per part of resin. Fillers for laminating resins have mainly been used in connection with mat reinforcements rather than with glass cloth.

Cure conditions may be varied widely to meet specific fabricator conditions. Pressures ranging from contact to 200 psi at temperatures ranging from 70 to 320 F have been employed successfully with both metallic and plastics molds. In all cases a post cure at 300 to 350 F has been effective in realizing maximum laminate strengths. Physical properties of properly post-cured room temperature systems approach those of heat-cured laminates. Data developed in connection with epoxy-furane systems also indicate that cures are carried out with development of a lower exotherm than that produced by conventional epoxide formulations. This should be of particular interest in the production of castings with appreciable part thickness where exotherm dissipation is a major problem.

Effective mold release is accomplished by using silicone fluid followed by a coat of paste wax. Film type separators of both cellulosic and vinyl types are satisfactory for non-metallic molds. In such cases a light coat of paste wax alone will provide optimum ease of separation.

Reinforcing materials

Satisfactory glass reinforcements include glass cloth, mat and roving. Volan A finish was found to be most effective for maintaining wet strength properties. Satisfactory results have also been obtained by using silane finishes such as Garan, No. 24, etc. Where open weave type glass cloths or mats are used, thixotropes should definitely be added to the resin in order to prevent excessive resin squeeze out. Contact pressure pre-cures have limited effectiveness with these reinforcements.

TABLE 6—EFFECT OF THIOKOL LP-3 ADDITIONS ON FLEXURAL STRENGTH OF EPOXY-FURANE LAMINATES

% LP-3	Flexural Strength, psi	Flexural Modulus psi x 10^6
0	74,800	3.38
5	68,590	3.53
10	56,500	3.02
12	50,100	3.05
15	47,630	2.83

What Materials Management Means

It means efficient use of engineering materials starting at the planning and design stages and continuing through manufacturing to the finished product.

by **Joseph Gurski**, *Ford Motor Co.*

■ The responsibility for materials management lies in the two broad areas of product-engineering and manufacturing. The engineers responsible for product design must be sure that the materials and design will produce a part that will do the job required; at the same time he must be aware of the latest manufacturing techniques in order to take advantage of reduced processing costs. Manufacturing and production departments must play a number of roles in materials management: purchasing, handling, processing, standardization, salvage, and repair.

Design and engineering

High processing costs and complex designs have given problems associated with planning and timing greater importance. In view of the necessity to release designs considerably ahead of production deadlines, and the obviously desirable goal of releasing designs which are correct and require a minimum of change or deviation, cooperation and liaison must exist between product designers and production departments. Designers, in specifying materials, must allow manufacturing all possible freedom in selecting the specific materials and processes consistent with production of parts satisfying end product requirements.

In the Ford Motor Co., materials engineers specify materials and processes in such a way as to allow a broad leeway for manufacturing departments. Ford believes that designers cannot tell a manufacturer what is wanted in a finished part and tell him how to do the job, too. To gain the most satisfactory results, the best procedure is to specify the desired attributes and permit latitude in materials and processing.

For example, Ford uses a bolt and stud standard to stabilize engineering drawings. The standard designates minimum physical requirements for various grades. Then a section of the standard lists the steels that are permitted for the various grades.

Grade	***Steel***
M-3500-A	AISI C-1013, SAE-1015, 1016, 1017, 1018, 1019, 1020 or 1022
M-3500-G	Alloy steel of 0.30-.45 carbon with sufficient hardenability to obtain a minimum "as quenched" hardness of rock 045 at the center of the threaded portion of the bolt after oil quenching.

Thus, the fabricator can select the material most suited for his processing.

Another provision in the standard permits the substitution of higher quality grades for the specified grades.

It can be readily seen that specifying a bolt by M-3500-A permits suppliers to standardize on any material that is best suited to their practice. Furthermore, the permitted substitution of a higher strength grade might preclude the necessity for making a special run of lower strength bolts for less severe service requirements.

During the application of specification M-3500-A, Ford developed a metal specification calling for a coiled 0.161/0.164 dia, cold drawn, cold-headed AISI C-1013 steel with a tensile strength of 68,000 psi min. An actual count shows that 35 different current producton bolts and 127 service bolts are cold-headed from this wire size.

Another device used to simplify materials selection at the design level is the Recommended Practice Specification. Excerpts from Spec. M-2K2, for the selection of carbon steels, show how the Recommended Practices operate:

1. *The Scope:* "This specification is intended to permit the widest possible latitude for manufacturing consistent with engineering drawing end requirements".

2. *The Requirements:* "This specification recognizes that different steels will give physicals that are equal to or better than those specified. It also recognizes that free cutting steel can be used instead of conventional steels".

3. *The Responsibility:* "Listing steels as options shall not be construed as a guarantee that they can all be fitted into a particular process. Proper processing is the responsibility of the supplier".

In practice, a Material Specification may call for SAE 1020 (M-2K2-E) steel. Now referring to the substitution chart, SAE-1020 (M-2K2-E) steel permits the use of AISI C-1023, SAE-1020, 1025, 1027, 1030, 1033, 1035 or M-2K2-F through K steels.

Specified Grade	***Approved Options***
H	A, B, C, E, F or G
A	B, C, E, F or G
B	C, E, F or G
C	E, F or G
E	F or G
F	G

In the M-2K2-F through K groups, there are 29 additional grades permitted. With all these options, manufacturing should not have to bother engineering for a deviation from metal specifications or wait 60 days for a change in blueprint.

Metal specifications in manufacturing

From original specifications, manufacturing takes over. Since drawings will not specifically detail material requirements, another means is used to record raw material requirements. This is done through a piece of paper called a "Metal Specification". Here details are given such as sizes, tolerances, shipping instructions, packaging information and pertinent metallurgical data. The data contained on this sheet is used as a purchasing authority when requisitions are issued.

It is undesirable for engineering to specify too much detail at the outset. Metallurigcal activities coordinating with process engineers must review the processing of the part. For example, if it decided that a part should be produced on an automatic screw machine, a free cutting steel SAE 1119 might be selected from among the permitted options of M-2K2-E. If hot rolled steel is used instead of cold drawn, a silicon of 0.10 max is specified and that special bar quality is called for. The steel must be pickled and machine straightened. At the time the drawing was completed no one knew exactly how the part was going to be made, so it would have been impossible to specify such details.

In ordering steel the specifying of precise detail is mandatory in order to get steel with the necessary qualities. There are about 20 metallurgical requirements for which extras are charged. If these are overspecified, then costs include properties which yield no benefit as far as the end product is concerned. In Ford's operations over 3000 metal specification sheets are used in one year, so the chances for error are numerous. Improper specifications could result in unnecessary payments of many thousands of dollars.

When the new steel pricing policies, base price plus extras, were established a number of years ago, Ford found that standard methods of specifying metallurgical properties in all divisions through development of Recommended Practices for metallurgical activities yielded great savings in time and materials cost. The scope of a typical recommended practice states: "This recommended practice outlines metallurgical properties which are commonly required to describe carbon steel bars for purchasing. It lays down rules for selecting variations of these properties and is intended to aid in establishing uniform specifications and to minimize cost extras."

The recommended practice covers such properties as types of steel, finish, silicon content, grain size, heat treatment, surface treatment and quality.

A few case histories show the background of several specification decisions:

1. Blueprints of rear spring leaves specified that the raw material, SAE-5160 steel have a maximum hardness of 300 Brinell to insure that the steel could be blanked. Review indicated that a specification for this hardness would involve a premium of $330,000 annually. A close study of price extra books revealed that calling for a specific hardness could be avoided by specifying "Suitable for Cold Shearing and punching as outlined in Steel Products Manual #10".

2. Investigation of a transmission gear, machined from hot-rolled alloy-steel bar that was pickled, oiled and machine straightened, revealed that the machine-straightening operation removed a good deal of the scale. A calculated risk was taken and the pickling and oiling requirement was removed. This resulted in a $45 per cwt. saving or an annual saving of $24,300.

3. Piston pin raw material was revised from tubing to bar stock. Because of the closeness of the raw material size to the finished diameter, a piston pin quality steel was required. A review of the processing showed that the piston pin quality requirement could be avoided. By magnetic testing, increasing the ordering size 0.010 in., and taking a slight calculated risk that surface imperfections would machine off, $50,400 was saved.

Standardization in manufacturing

Savings through standardization are often difficult to compute, but they occur in almost all departments. Some of the most obvious beneficiaries are engineering, purchasing, materials handling and manufacturing. In all of these areas red tape is reduced and the flow of paper minimized. Reduction in paper work not only reduces labor and overhead, but reduces the elapsed time necessary to complete a job.

In engineering, standardization and simplification will facilitate the evaluation of new materials, reduce the time spent in putting special information on engineering drawings, promote uniformity and accuracy and reduce the number of change and deviation requests.

In purchasing, the work of writing, placing and following up orders is reduced. Larger quantities can be purchased, minimizing quantity extras. Buying can be done on the basis of competitive bids, and multiple sources established to insure that materials will be available at all times.

In materials handling, standardization results in a more effective utilization of space and fewer items in inventoring. Delivery is expedited, and there are fewer losses due to obsolescence.

In manufacturing, personnel become more familiar with the reduced number of materials, know-how becomes more effective, and scrap losses are lower because materials are utilized more efficiently. In addition, standardization and simplification facilitate exchange of information between departments in different locations.

Recommended practices in standardization

Standardization and simplification of materials in the Ford Motor Co. are achieved through development and use of the "Recommended Practices" mentioned earlier. The SAE defines recommended practices as "recommendations based on sound engineering principles intended as guides toward standard engineering practice". They may take a variety of forms, but all have one thing in common: they establish basic attributes of materials as criteria for selection for various applications. These criteria may be dimensional, chemical, metallurgical or any other which could affect their suitability.

Recommended practices serve as a guide to unify thinking and promote the use of standards. They highlight pertinent factors that should be considered in selection of materials and point out when there is a need for evaluation of new materials. Recommended practices are difficult to develop, but the difficulties involved only serve to underline their importance. Without recommended practices the same reasoning and selection process must be repeated every time a material is specified.

A basic consideration in standardization and simplification is using national standards, such as SAE, ASTM or ASA, where they are available. Developing and using a system of company specifications as opposed to the use of trade name designations of vendors is also desirable. Such a system very effectively controls composition and performance, permits competitive bidding, reduces cost and inventories, and promotes availability. All of these factors work to reduce costs.

The responsibility for developing specifications in the Ford Motor Co. is assigned to the Manufacturing Research Dept. New specifications may be developed as a result of investigating the use of new materials and processes to improve operations, or by request from manufacturing divisions. Divisions may request assignment of "M" numbers, and if no materials to do the required job are in the system, "M" numbers are assigned and specifications are written to describe the desired materials.

After a period of time, when it is apparent that a specification should be considered as a standard, the proposal is referred to a Materials and Processes Standards Committee. This committee, composed of representatives of the various divisions in the Ford Motor Co., acts on the proposal and if agreement is reached, the specification is published as a standard in the Manufacturing Standards Books.

In order to achieve simplification, the Manufacturing Research Dept. periodically reviews standards and prepares recommended practices which describe conditions under which related materials are to be used. This eliminates a considerable number of materials with only minor differences of composition or properties that have crept into the system. These recommended practices are circulated for comments to all affected personnel and are issued as a guide to metallurgical personnel.

An example of what can be achieved through use of recommended practices is the case of hot rolled bar steels. Where hot rolled bar steels are purchased, the size of the raw material must be controlled closely. Obviously, if too large a size is specified, metal will be wasted and processing costs increased. If too small a size is specified, there is a possibility that the machining operation will not clean the surfaces sufficiently and in addition, may result in the retention of seams that were present in the raw material. The purpose of the recommended practice is to furnish a base line from which to operate. Probably no company follows such recommendations completely.

Information on this recommended practice is based to a large extent upon the recommendations of the American Iron and Steel Institute and on experience. In no case is more material allowed than is recommended by AISI, and in many cases the allowance is less. This means that a calculated risk is taken in those cases; however, it is felt that the insurance premium required by specifying more metal is too great for eliminating the small risk of producing an unacceptable piece. The following examples illustrate the effect of increasing ordering sizes by 1/16 in. It should be recognized that many times the cost of metal saved is only a small part of the saving, since metal-removal costs are high.

CRANKSHAFT PULLEY HUB SPACER
(HOT ROLLED CARBON STEEL)

ORDERING SIZE (IN.)	RAW METAL WEIGHT (LB)
1 11/16 (Dia) x 1 11/32 (Multiple)	0.876
1 3/4 (Dia) x 1 11/32 (Multiple)	0.943

ANNUAL INSURANCE COST
FOR METAL ONLY

0.067 x $.0515 x 1,000,000 = $3,450

Preferred sizes of flat metals is another example of a recommended practice used by Ford's engineering departments as a standardizing medium. As one can see from a table of #20 gage

TRANSMISSION GEAR
(HOT ROLLED ALLOY STEEL)

ORDERING SIZE (IN.)	RAW METAL WEIGHT (LB)
3 3/16 (Dia x 1 29/32 (Length)	4.55
3 1/4 (Dia x 1 29/32 (Length)	4.69

ANNUAL INSURANCE COST
FOR METAL ONLY

0.14 x $0.0765 x 1,000,000 = $10,710

sizes, specifying a thickness by a gage alone would be a constant source of confusion, and it has always been necessary to specify the decimal thickness in addition to the gage number. Accordingly, when the ASA standards become available it will be desirable to adopt the use of this standard.

Many activities of Ford Motor Co. have benefited from preferred-size simplification. Engineering departments, for example, have found it unnecessary to refer to different handbooks in order to determine gages available and the decimal sizes of such gages. Engineering drawings used to spell out "#20 MS gage (0.0359 in.)". Now they say "0.036 in. thick". When you consider the magnitude of the operations the mere writing of such information on 25,000 drawings a year is worth something. However, the savings in engineering departments are relatively small, but since they basically decide what manufacturing is to buy, their effective use of such a standard is all-important.

The accompanying table shows a study made in 1953 and illustrates one of the savings that can be calculated with some degree of accuracy. The use of preferred sizes reduced the number of ordering sizes by permitting the grouping of like thicknesses. The reduction in ordering sizes necessitated the placing of fewer orders and resulted in a yearly saving of at least $73,000.

The effect of combining steel sizes can be seen from another table. By combining requirements of like thicknesses to increase ordering amounts a more favorable price was possible for these otherwise small orders.

This article was adapted from a paper presented at the SAE Golden Anniversary Production Meeting and Forum, Cincinnati, Ohio, Mar., 1955.

SIMPLIFICATION OF THICKNESS SPECIFICATIONS

Standard as a Preferred Thickness	Simplified Ford Standard	Standard as a Preferred Thickness	Simplified Ford Standard	Standard as a Preferred Thickness	Simplified Ford Standard
0.236	0.236	0.075	0.075	0.022	—
0.224	—	0.071	—	0.021	0.021
0.212	0.212	0.067	—	0.020	—
0.200	—	0.063	—	0.019	—
0.190	—	0.060	0.060	0.018	0.018
0.180	0.180	0.056	—	0.017	—
0.170	—	0.053	—	0.016	—
0.160	—	0.050	—	0.015	0.015
0.150	0.150	0.048	0.048	0.014	—
0.140	—	0.045	—	0.013	—
0.132	0.132	0.042	0.042	0.012	0.012
0.125	—	0.040	—	0.011	—
0.018	0.118	0.038	—	0.010	0.010
0.112	—	0.036	0.036	0.009	—
0.106	0.106	0.034	—	0.008	0.008
0.100	—	0.032	0.032	0.007	—
0.095	—	0.030	0.030	0.006	0.006
0.090	0.090	0.028	—	0.005	—
0.085	—	0.026	0.026	0.004	—
0.080	—	0.024	0.024	0.003	—

SAVINGS EFFECTED IN HANDLING PURCHASE ORDERS OF FLAT METALS

	1949	1953	1953 Adjusted to 380 Parts
Number of Metal Specifications	365	246	168
Number of Actual Parts	380	552	380
Actual Parts Per Metal Specification	1.04	2.25	2.25
Number of Different Thicknesses	37	10	10
Reduction in Metal Specifications (365-168)	—	—	197
Orders Placed and Releases Issued Per Year Per Metal Specification	—	—	15
Cost of Processing Each Release or Order	—	—	$25
Saving Per Year (197 x 15 x 25)	—	—	$73,875

SAVINGS EFFECTED BY COMBINING STEEL SIZES

Steel Size (in.)	Monthly Requirement(lb)
0.075 x 36⅞ x 75½	$50,000[a]
0.075 x 5¼ x 75½	6500
0.075 x 6⅛ x 75½	6000
0.075 x 7⅝ x 75½	5800
0.075 x 7 35/64 x 36⅞	6700
0.075 x 4 3/32 x 75½	5500
	30,500
Warehouse Cost 30,500 lb at 0.085	$2592.50
Mill Cost 30,500 lb at 0.053	$1616.50
Monthly Saving	$ 976.00
Yearly Saving (976.00 x 12)	$11,712.00

[a] *Basic volume order, to which smaller orders are added to take advantage of volume discount.*

Materials Selection for Critical Parts in Chlorinator

In the Fischer & Porter Co.'s 1050 Chlorinator, which adds chlorine gas at a measured rate to a stream of water, selection of critical materials was based on the following three factors, in descending order of importance: 1) Resistance to corrosion; 2) maintenance of performance specifications throughout service life; and 3) cost of materials. Materials for parts shown in the accompanying sketch were selected on their merits in the following manner:

Tantalum: Used where it is desirable to maintain dimensions for accuracy, i.e., valve plugs, guides and stems which must move.

Teflon: It is inert to corrosive action of chlorine. It is self-lubricating minimizing friction in moving parts. It is used for valve seats, guide bushings and gaskets where movement occurs and where corrosion would result in leakage.

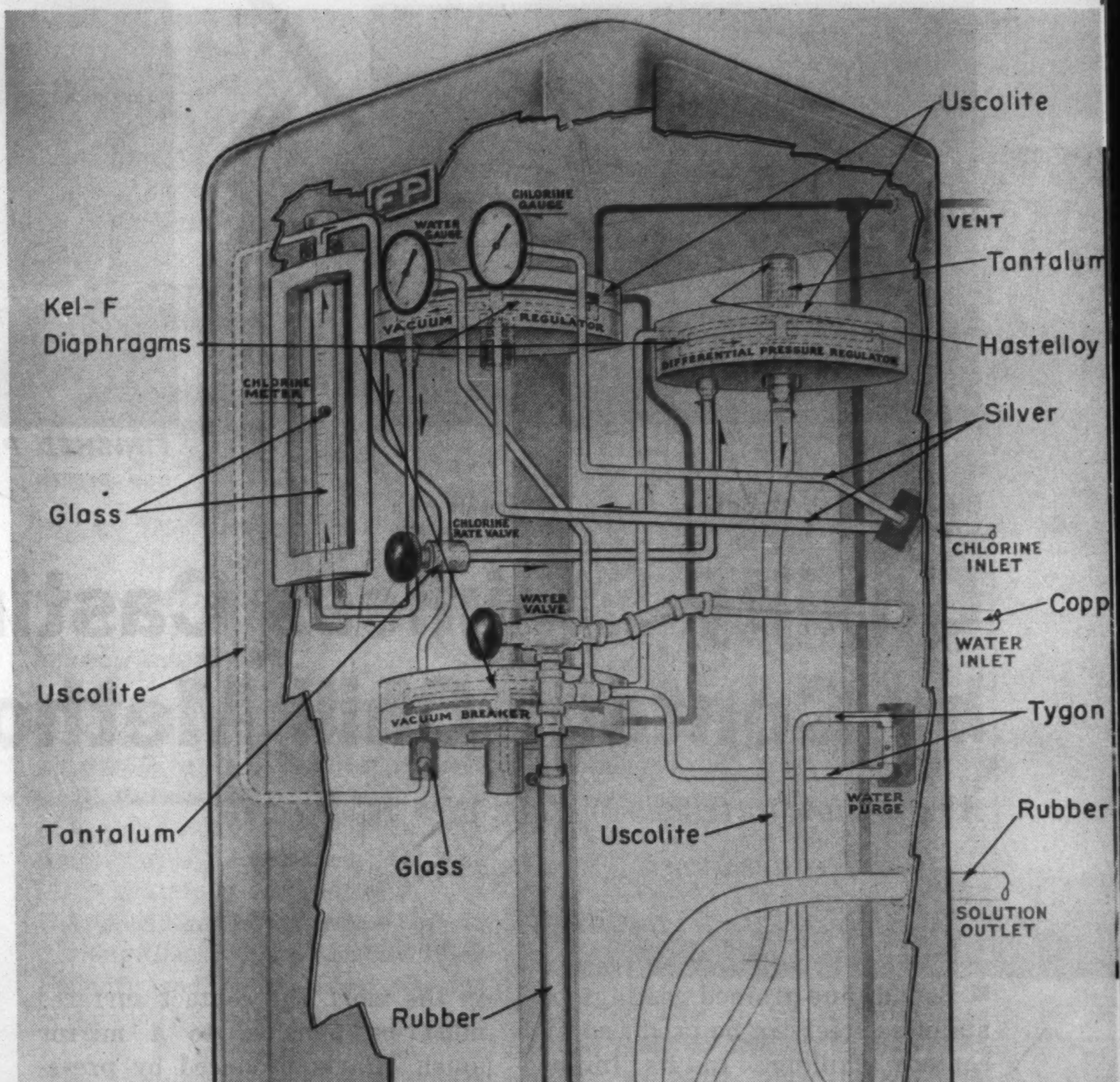
Silver and Hastelloy: Used where high pressure must be contained without deformation and where maintenance of original dimensions is not imperative.

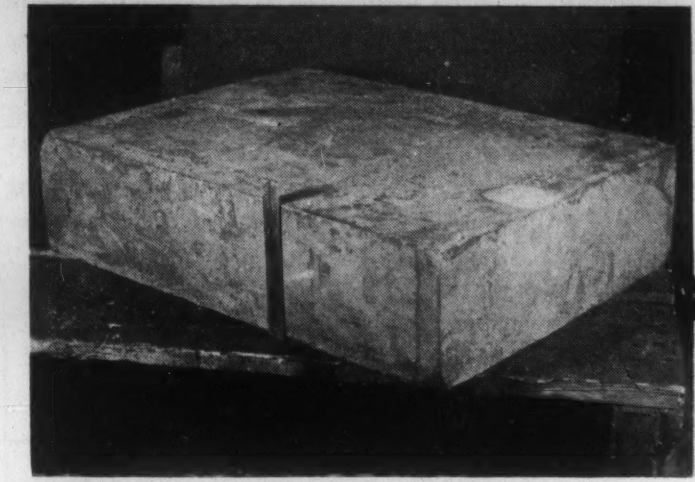
Uscolite: Used in main body components, low pressure piping, fittings, ejector block, etc., where strength is desirable but where high pressure is not encountered.

Kel-F: It retains flexibility under long exposure to chlorine gas. It is used for diaphragms since it does not become brittle with age.

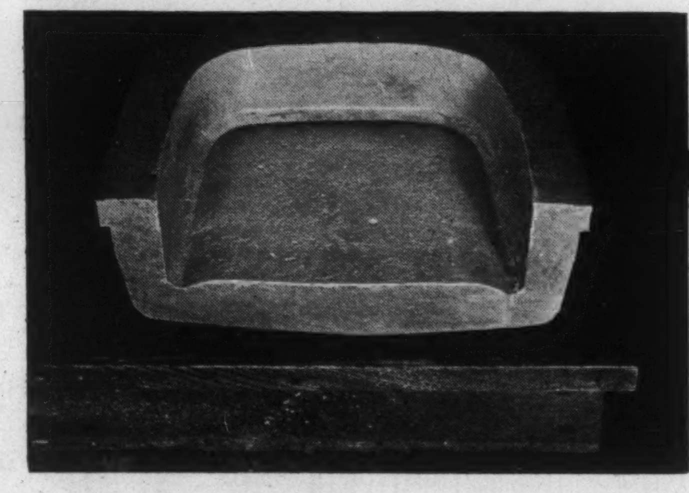
Glass: Used in metering tube where visibility is essential.

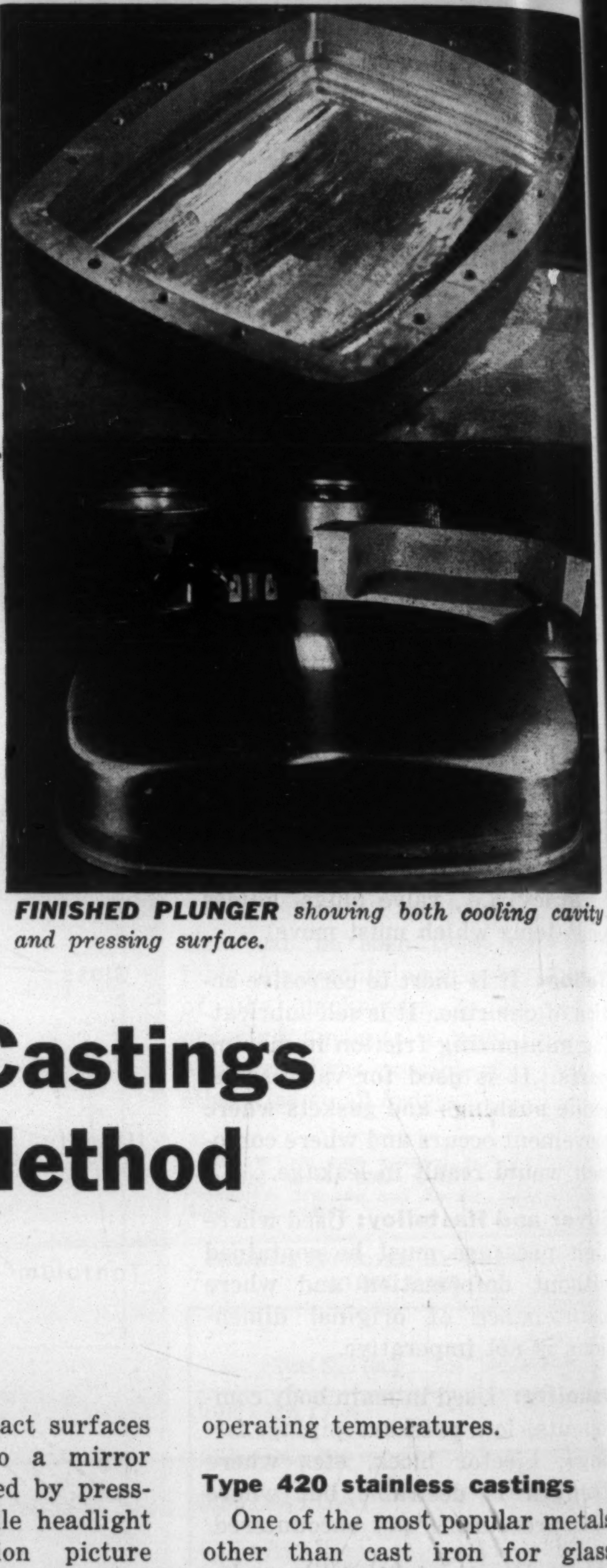
Glass-reinforced plastics: Used in enclosing cabinet because it is inert to corrosion, requires no painting. It is light, strong and durable.


Uscolite
VENT
Tantalum
Hastelloy
Silver
FP
WATER GAUGE
CHLORINE GAUGE
VACUUM
REGULATOR
DIFFERENTIAL PRESSURE REGULATOR
Kel-F Diaphragms
CHLORINE METER
Glass
CHLORINE RATE VALVE
CHLORINE INLET
Copp
WATER VALVE
WATER INLET
Uscolite
VACUUM BREAKER
Tygon
WATER PURGE
Rubber
Tantalum
Glass
Uscolite
SOLUTION OUTLET
Rubber
EJECTOR ASSEMBLY
Glass
Glass-Reinforcing Plastics
DRAIN
Tygon
Sil Unit
Uscolite



***OLD**—Upset forged block for plunger.*
***NEW**—Section of contour chill casting.*





***FINISHED PLUNGER** showing both cooling cavity and pressing surface.*

by Roland E. Groethe, *Corning Glass Works*

Quality Stainless Castings by Contour Chill Method

Application to television tube dies resulted in:

- *Reduced cost*
- *Savings in material*

■ Sound, fine-grained castings of stainless steel can be produced by contour chilling. In its initial application, dies for pressing glass television bulbs have been produced with a weight saving up to 60% and a saving in machining time up to 100 hr per casting over the replaced forgings.

Pressed glass components are formed by squeezing a gob of glass to shape in a metal plunger and mold assembly. Relatively high temperatures are used, service is severe and mold requirements are exacting. Since the glass reproduces any imperfection in the mold, the contact surfaces must be polished to a mirror finish. Parts produced by pressing include automobile headlight components, television picture bulbs, lenses and baking dishes.

Desirable features in the metals used for molds for glass pressing are: 1) economical metal cost; 2) ability to be machined and polished economically to a mirror finish; 3) relatively high thermal conductivity; 4) relatively low coefficient of thermal expansion; 5) sufficient surface stability, thermal shock resistance and thermal fatigue strength at operating temperatures.

Type 420 stainless castings

One of the most popular metals other than cast iron for glass mold equipment is type 420 (12% chromium, 0.35% carbon) stainless steel. Surface stability of this steel under oxidizing conditions is quite good and thermal fatigue strength is sufficient for the more severe applications.

To obtain dependable metal quality for the production of the plungers, upset forged blocks of type 420 were specified even though metal cost, machining cost and machining delay time were excessive. With the increase in bulb sizes and the change to a rectangular shape, machining of forged blocks became increasingly difficult and expensive. To overcome these difficulties, chill casting of the plungers was suggested.

Sand casting of type 420 stainless is troublesome because of random shrinkage and porosity. Use of chills on the outside contour yields dense, fine-grained castings. Contour chilling also moves the so-called center-line shrink zone from the vicinity of the chilled surface toward the less important surface. Depending on chill thickness and other factors, this zone appears at a depth of about 85% of the wall thickness from the working surface.

In this case, chill casting improves casting quality and produces castings competitive with forgings. The actual cost of chill castings is only slightly higher than that of sand castings as additional costs are limited to chill patterns and chills.

Contour chill castings, developed in collaboration with Jessop Steel Co. and Lebanon Steel Foundry, have performed in service as well as upset forgings. The castings have a number of advantages. A cast blank for a 21 in. TV bulb plunger weighs 60% less than a forged blank and represents a real cost saving. Using stainless steel chill cast plungers and molds, quality control inspection of the metal is reduced to a minimum and no size limitation has been encountered. Machining time is greatly reduced and there is no difficulty in obtaining surface finishes of cutlery quality with a mirror finish. Such finishes have been produced on cross-sectional areas as large as 1000 sq in.

Possible applications

Contour chill casting of dies is adaptable to other service also. This procedure should be considered as a production method when: 1) a few dies of a special composition are required, 2) it is advantageous to be able to core out unneeded metal, and 3) special rollers having taper, contours or integrally-cast flanges are desirable.

Contour chill casting appears to be suitable for applications in a number of other fields including:

1. Rubber tire molds for short runs and quantity production.
2. Tube reducing dies for tube rocking machines. If they were made as contour chill castings instead of forgings, they could be cored on the reverse side with substantial weight saving.
3. Corrosion resisting castings for the chemical industry. In some instances the dense uniform chill zone produced by this procedure presents an excellent barrier to localized attack or pinhole corrosion.
4. The production of larger alloy steel anti-friction bearing races.

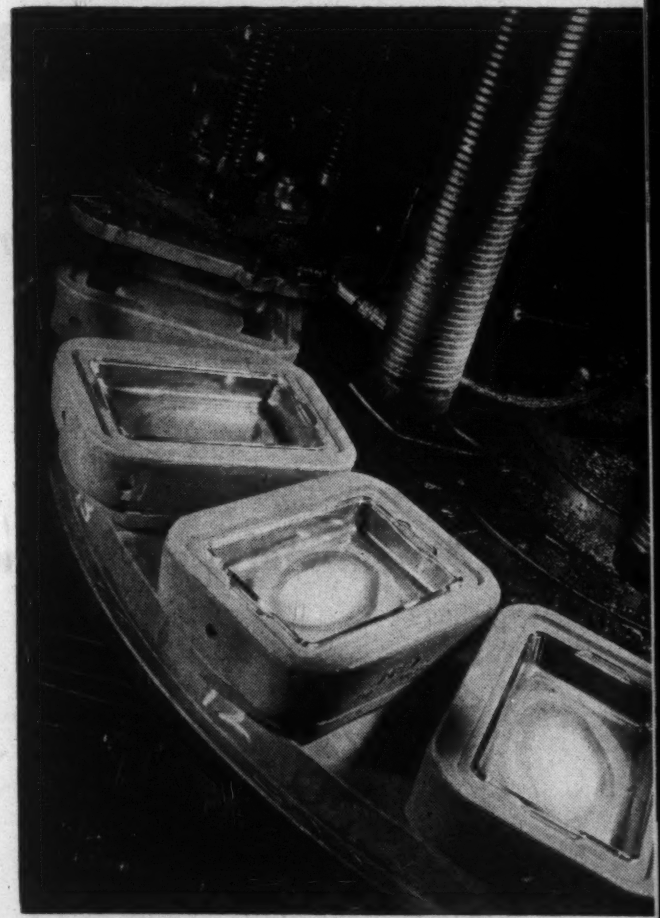
Acknowledgements

The assistance of the Metallurgical Department in preparing this article and the cooperation of Messrs. D. R. Mattoon, E. A. Spencer, C. F. DeVoe and A. W. Weber of Corning Glass Works in preparing this article is gratefully acknowledged.

Appreciation is expressed also to Corning Glass Works, Lebanon Steel Foundry and Jessop Steel Co. for permission to publish it.

This article is based on a winning entry in Product Development Contest, 1954, Steel Founders' Society of America.

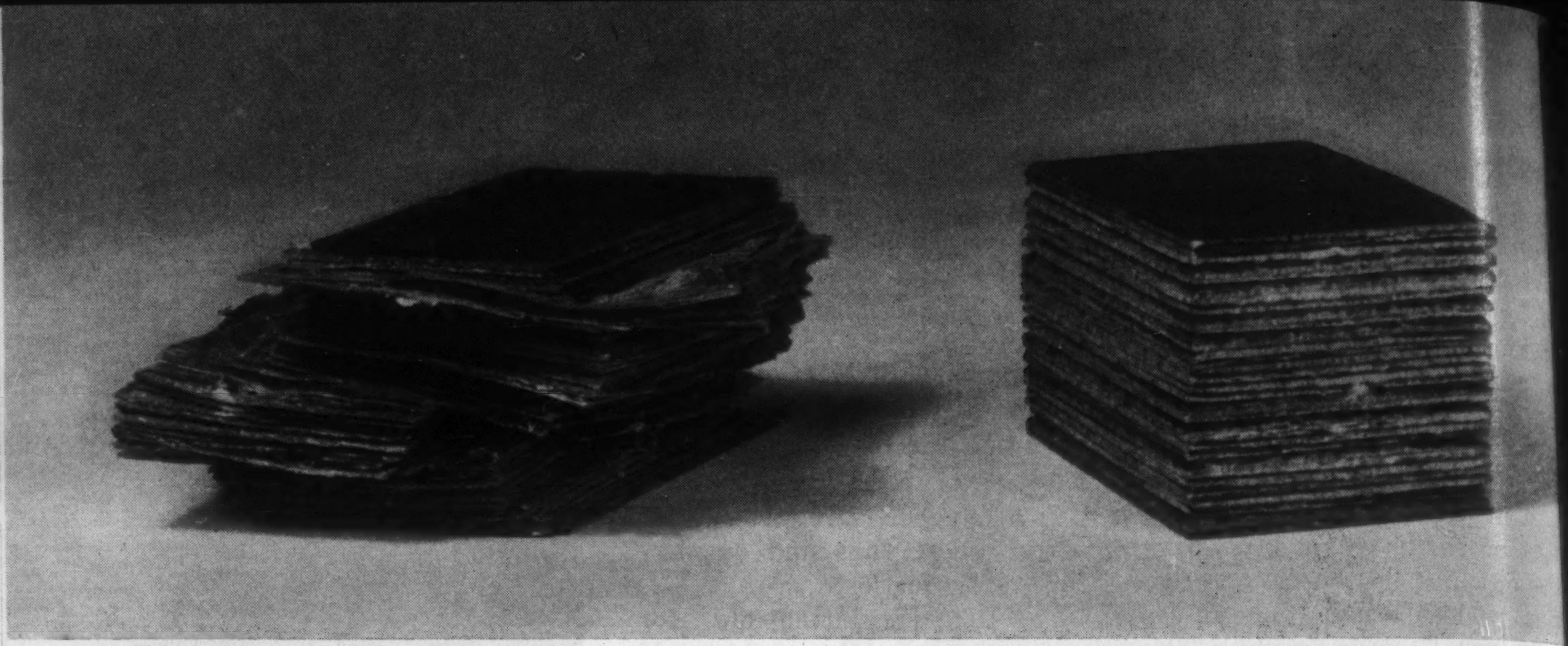
Various articles *produced by pressing hot glass in a mold.*



Service life *of the mold used in glass pressing depends on such variables as glass temperature, mold material and production rates.*

COST SAVINGS OF CASTING AS COMPARED TO ORIGINAL FORGING

Item	Forgings	Castings
Raw Material Weight	560 lb	220 lb
Raw Material Cost	$450.00	$150.00
Machining Cost	$200.00 greater than for a casting	—
Sub Total	$650.00	$150.00
Savings Each Die (Plunger) When Cast	$500.00	



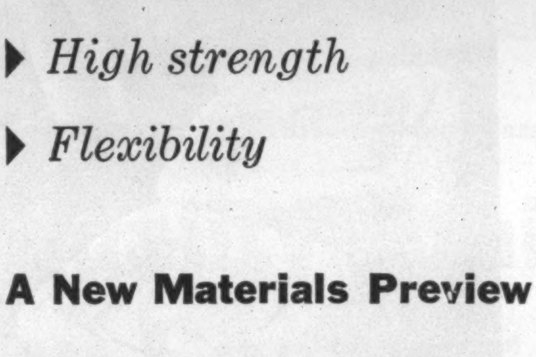
Shellac-bound mica *splitting segment insulation is shown at left while epoxy-bonded isomica segment plate is at right. Both have been subjected to compression test at 20,000 psi at 400 F.*

New Epoxy-Bonded Mica Insulation

Has—

- *High dielectric properties*
- *High strength*
- *Flexibility*

A New Materials Preview



Note high stability of epoxy-bonded mica in comparison with that bonded with shellac.

■ Thermal, chemical, mechanical and electrical properties superior to those of other available types of insulation are claimed for a new Class B insulating material which combines insulating properties of reconstituted mica with those of epoxy resins. Available in both flexible and rigid forms, the material consists of Isomica, impregnated with various epoxy resins. Isomica is reconstituted mica sheet, made from small flakes of mica. In cured form, epoxy Isomica is available as rigid segment plate. In the semi-cured state it is available as plate for molding, or as tubes, channels and other shapes molded to customer specifications. In flexible form, the material is available as sheet or tape wrapped by hand or machine and fully set by additional polymerization with short cures at low temperatures.

Previously, reconstituted mica sheet has been available with various types of binders, including shellac, alkyds and silicones. Although the new material is not intended as a replacement for the silicone type, it is expected to provide manufacturers of electrical equipment with outstanding advantages as compared with shellac or alkyd-bonded micaceous materials.

Flexible forms

According to Mica Insulator Co. of Schenectady, developers of the material, the flexible sheet and film can be thermoset to form a homogenous, void-free insulation offering better electrical protection under thermal and mechanical stress than other available insulating materials. Produced in continuous form, tapes can be reinforced with glass, polyester film, etc., to provide additional tensile strength and handling qualities. Sheets may be supplied with or without reinforcement.

Some of the advantages claimed for the material are: 1) high moisture resistance; 2) freedom from voids, providing better thermal conductivity; 3) high mechanical strength; 4) resistance to stress caused by different co-

TYPICAL PROPERTIES OF EPOXY-BONDED MICA IN VARIOUS FORMS

Form	Property	Test Condition	Value
Flexible Sheet and Tape	Dielectric Strength (after cure) v/mil	0.018-in. unreinforced sheet, tested with 2-in. electrodes at 73 F, 50% R.H.	1000
		After conditioning 96 hr., 73 F, 96% R.H.	800
	Volatile Content, %	As received	1
	Corrosive Effect on Copper		None
	Adhesion	To copper and other metals	Good
	Temperature Classification		Class B
Molding Plate	Dielectric Strength, v/mil	Short time ASTM D149-44, 0.030 in. thick	1300
	Arc Resistance, sec	ASTM D-495	180
	Flexural Strength, psi	⅛ in. thick	50,000
	Thickness Tolerances, in.		
	Milled		±0.0005 avg ±0.001 ind
	Unmilled		±0.002 avg ±0.003 ind
	Flaking		None
	Resistance to Oils, Chemicals and Moisture		Excellent
	Weight Factor, lb/cu in.		0.073
	Temperature Classification		Class B
Segment Plate	Dielectric Strength, v/mil	Short time ASTM D-149, 1/32 in. thick	1500
	Arc Resistance, sec	ASTM D-495	180
	Angular Stability, in.	ASTM D-352 (proposed), after 15 min.	0.003-0.005
	Compression Set, %	ASTM D-352 (proposed)	1.8
	Compression, %	ASTM D-352 (proposed)	2.5
	Compressive Creep, %	ASTM D-352 (proposed)	1.9
	Stability (perpendicular)	20,000 psi for 5 min at 460 F	No sliding or oozing
	Weight Factor, lb/cu in.		0.085
	Temperature Classification		Class B

efficients of expansion of insulation and conductor; 5) high dielectric strength; 6) high arc resistance; and 7) good resistance to oils, chemicals and other contaminants encountered under severe operating conditions. As-purchased, the flexible material is said to have good shelf life for extended periods. Typical properties are shown in an accompanying table.

Molding and segment plate

Epoxy Isomica molding plate is available for use in such applications as commutator cones, slot armor and ground insulation. It is purchased as a semi-cured material which can be stored for extended periods of time without deterioration. According to Mica Insulator, molded commutator rings, when used in conjunction with epoxy Isomica segments will produce, after a short cure, a commutator which will resist pressures of 10,000 psi at temperatures up to 300 F. Suggested cure is a 1-hr bake at 300 F after commutator has been brought to temperature, put under pressure and tightened.

The material in segment plate form was developed to serve as commutator segment insulation providing optimum stability under heat and pressure. It is said to have a high degree of uniformity of thickness, and good resistance to moisture, oils and chemicals. Laminated under heat and pressure, the segment plate has good resistance to shear and compression, due to the high mechanical strength and bonding characteristics peculiar to epoxy resins. Freedom from flaking and slippage permits greater ease of commutator assembly and processing.

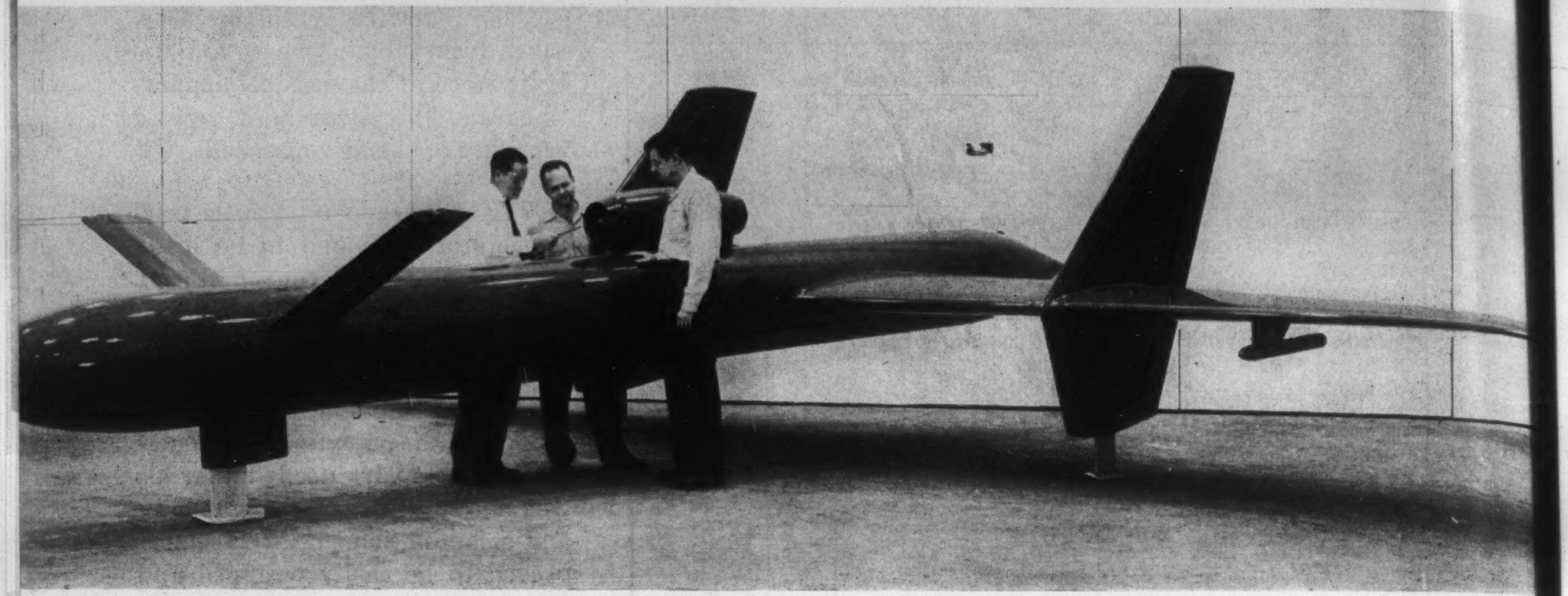
Case histories

The following case histories taken from industry serve to illustrate some of the possible applications and the advantages derived from use of the new material.

■ A coil wrapper for high voltage stator coils had to be made of a flexible micaceous material. After cure, test coils with 0.084-in. wall thickness had to withstand 18-19 kv high potential. All production coils had to withstand 12 kv high potential. Difficulty with previously used materials was due to voids, swelling, puffing and delamination. Epoxy Isomica proved to be easily wrapped and test coils withstood 24 kv with no signs of breakdown.

■ To serve as slot insulation on generator rotors a micaceous insulation was required with sufficient mechanical strength to resist damage during assembly operations. Cured insulation was required to withstand 15,000 psi compressive force at 300 F. Electrical requirements called for 0.070 in. of insulation to hold up under 20-23 kv potential. Other materials had poor compressive strength, cracked on the bends, and delaminated and cracked under on-off load cycling. Epoxy Isomica withstood 15,000 psi at 300 F for 5 min. After cycling 200 times between 120 and 300 F there was no cracking or delamination, and electrical breakdown on the 0.070 in. thickness was above 40 kv. Additional time and labor savings were incurred in laying up and molding the channel prior to insertion in slots.

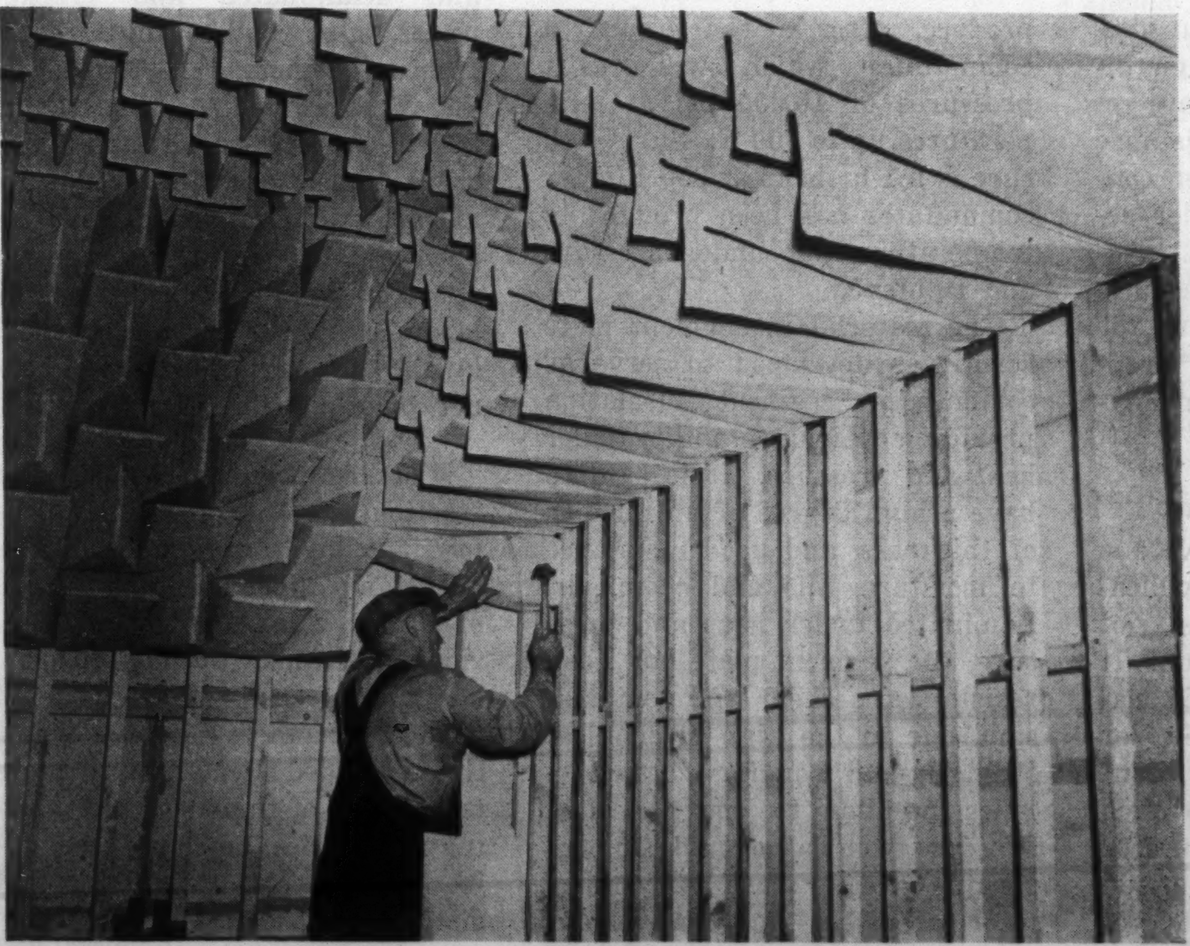
■ Molded channel insulation for traction motor coils had to be mechanically strong and able to withstand application to the coil of 10,000 v high potential. Previous materials were non-uniform, had poor mechanical strength and molded channels sprang back. Epoxy-bonded mica provided more uniformity of thickness and molding properties, and reduced rejections due to springback and distortion.



Magnesium and Plastics Make Light Jet Target

Magnesium semi-monocoque construction and glass-reinforced plastics join to make a light-weight gunnery target that can be towed at speeds of over 500 mph. The thick magnesium skins minimize need for bulkheads, ribs and spars. Castings are Al-Mag 35 and the bridle post structure is a one-piece magnesium extrusion. Nose, tail section and fairings are laminated plastics. Total weight is approximately 1425 lb.

External magnesium surfaces are dichromated, zinc-chromate primed and enamel painted. Internal magnesium is dichromated and zinc-chromate primed. Trailing edges of vertical fins, wings and flaps consist of Bondolite sandwich construction with no internal support. Both electrical and hydraulic power necessary for performing evasive maneuvers are provided by a ram-air driven turbine in a pod above the fuselage.

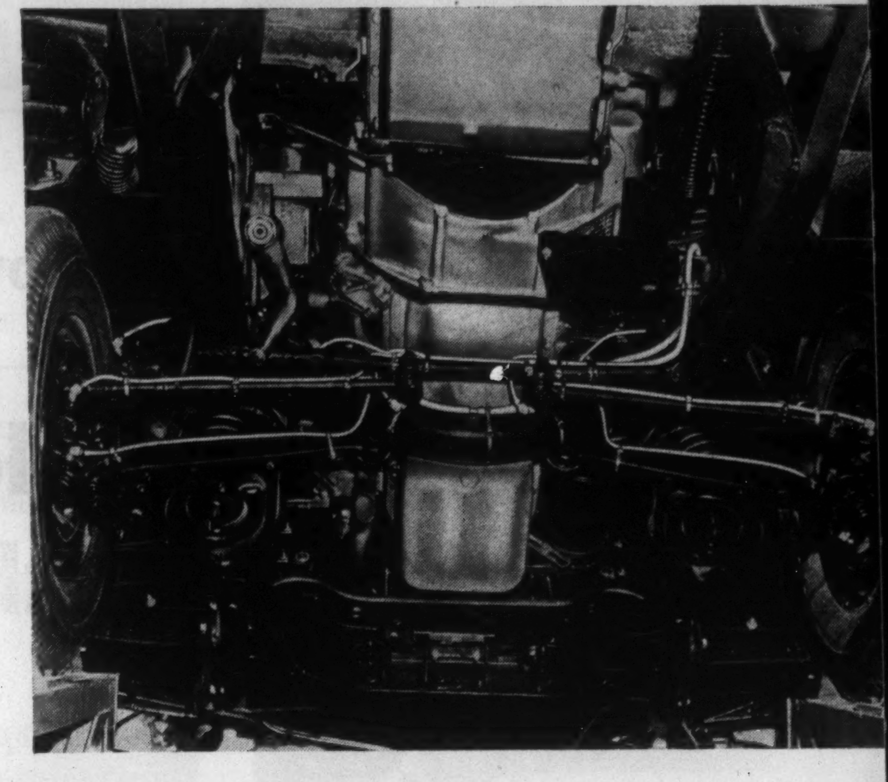


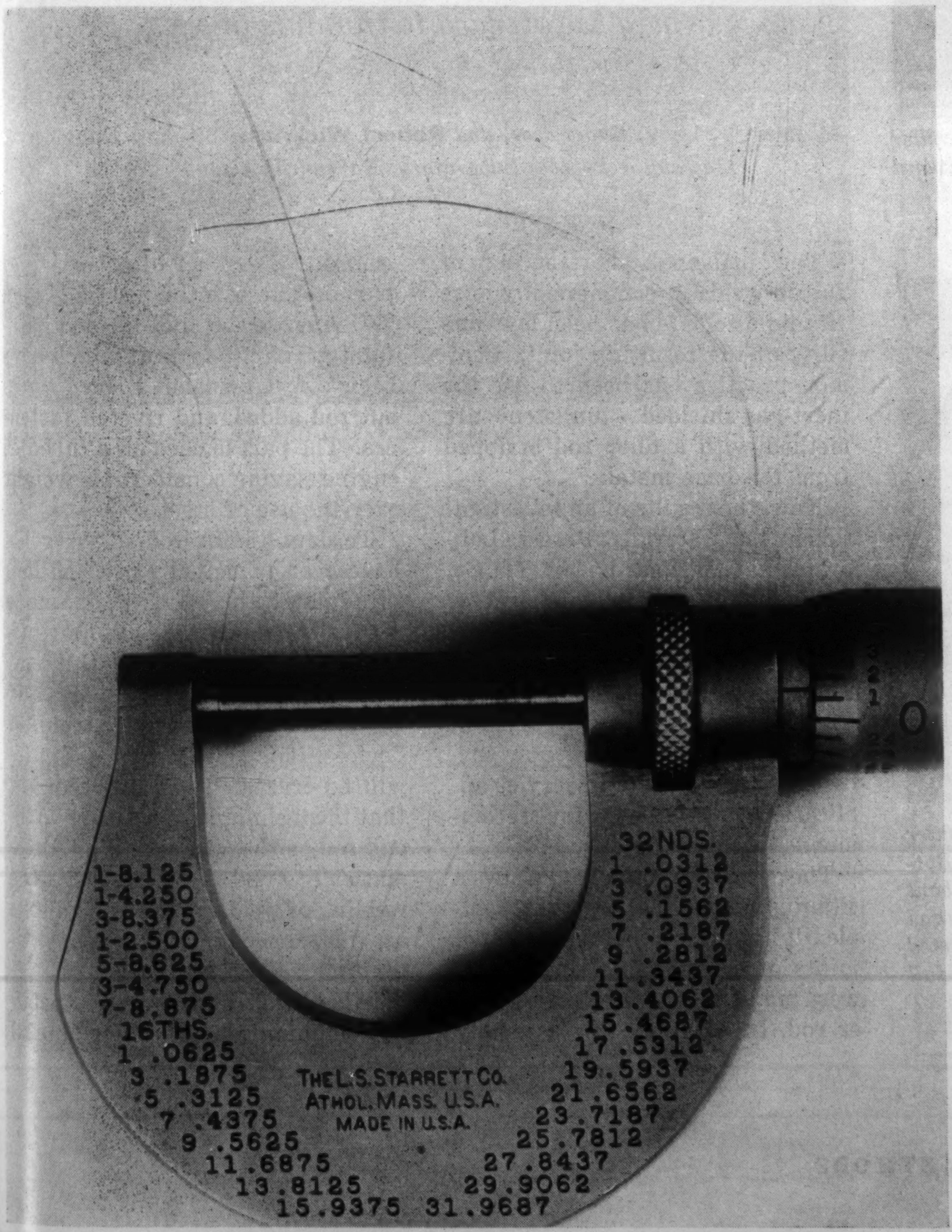
Glass Muffler Chops Noise

Workman is installing one of 2500 wedges made of plastics-impregnated glass fibers in the anechoic chamber of the Parmly Foundation for Auditory Research at Illinois Institute of Technology. Each wedge is 2 ft long. Set on Neoprene pads, the chamber is surrounded by a 2-ft air gap and further protected from outside noise and vibration by a concrete building lined with 2-in. slabs of glass fiber material.

Nylon Tubing Greases Cars

Nylon tubing is being used to carry grease to chassis bearings in this central lubricating system developed by Lincoln Engineering Co. Available on '55 Fords and Mercurys, the feed system consists of seamless ⅛-in. o.d. tubing made of DuPont's nylon and fabricated by the Polymer Corp. Materials specifications called for a burst strength of 2500 psi; toughness with flexibility; and ability to withstand vibration, constant flexing, salt, gasoline, oil, grease, normal solvents, and a wide service temperature range. Nylon tubing met all these specifications and can be easily pre-assembled into harnesses for rapid installation.




1-8.125
1-4.250
3-8.375
1-2.500
5-8.625
3-4.750
7-8.875
16THS.
1 .0625
3 .1875
5 .3125
7 .4375
9 .5625
11.6875
13.8125
15.9375
THE L.S.STARRETT CO.
ATHOL, MASS. U.S.A.
MADE IN U.S.A.
32NDS.
1 .0312
3 .0937
5 .1562
7 .2187
9 .2812
11.3437
13.4062
15.4687
17.5312
19.5937
21.6562
23.7187
25.7812
27.8437
29.9062
31.9687

Smallest Nickel Tube?

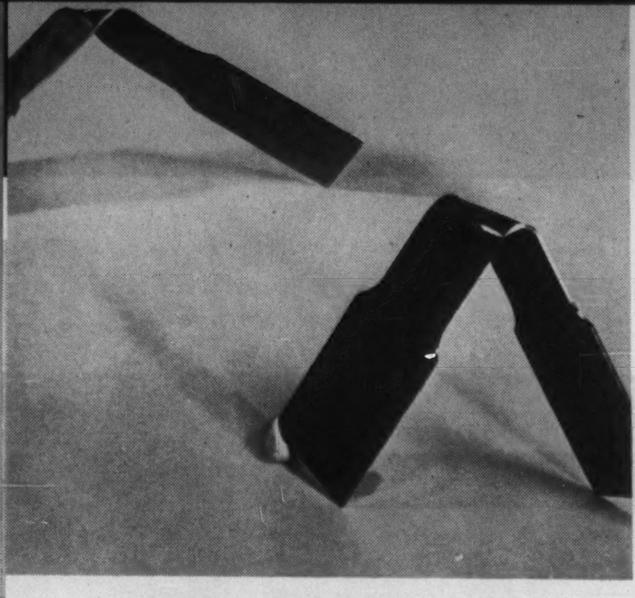
Nickel tubing measuring only 14/10,000 in. o.d. is drawn down from 2-in. seamless tubing in 43 separate drawing operations by Superior Tube Co. A bundle of about 18,000 of the tubes could fit inside the bit of a man's pipe, the i.d. of the tube being about one third the thickness of a human hair. Diamond dies are used to draw sizes from 0.115 in. on down. No commercial use for the tube is yet known.

Improve joint ductility by

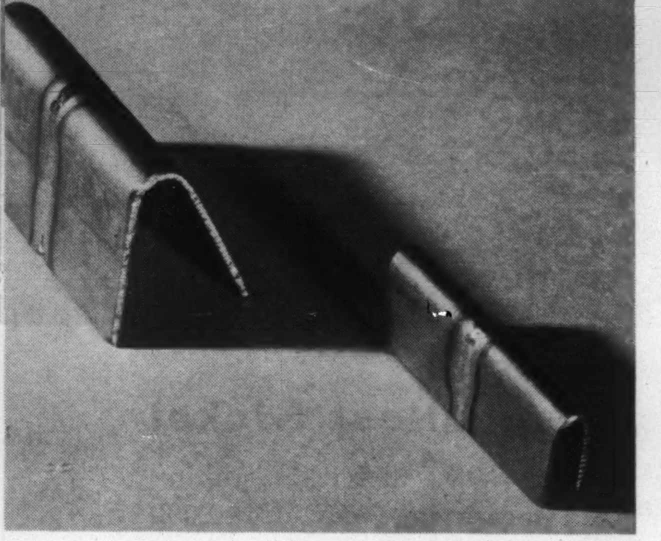
Welding Titanium Without Filler Rod

Recent experience with "no-rod-added" welds revealed improved joints and resulted in less grinding.... Technique may be extended to titanium alloys.

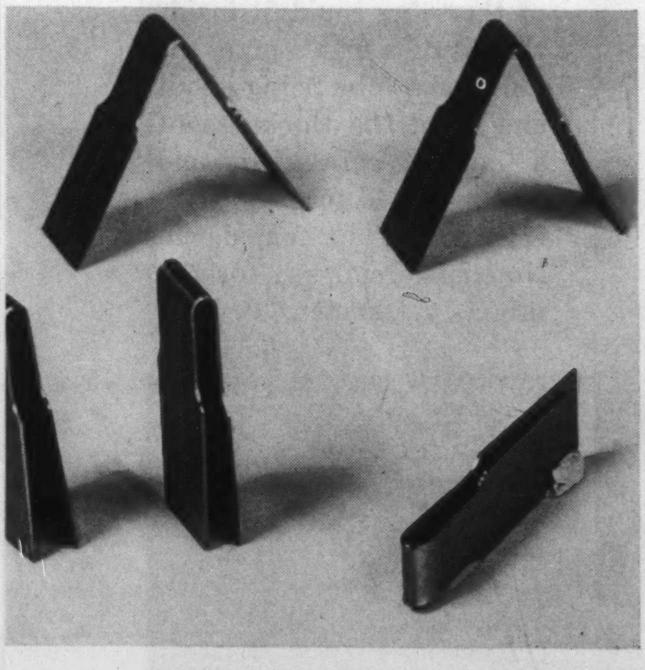
by **Alan V. Levy,** *Supervisor, and* **Robert Wickham,** *Welding Engineer, Material & Process Laboratory, Marquardt Aircraft Co.*



Bends diagonally across weld *Left, filler metal added. Right, no filler metal added.*



Bends across weld *Left, filler metal added. Right, weld without filler rod.*



Bends parallel to weld *Top, filler rod added and bent to failure. Bottom left, filler rod added and bent along weld. Bottom right, filler rod added and bent along heat effected zone. The latter sample did not fail even at 190 deg bent over a 2T radius mandrel.*

■ The principal shortcoming of fusion welds in commercially pure titanium to date has been low ductility of the resulting joint. Common practice has been to use the inert-gas-shielded tungsten arc method with a filler rod stripped from the base metal.

Now, the results of an investigation by the Material & Process Laboratory at Marquardt Aircraft Co. show that the complete character of the joints can be improved by welding titanium without filler rod. The no-rod-added fusion welded joint has been successfully tried in limited production and is now successfully performing in service applications. (See box for recommended welding conditions.)

The accompanying photo shows a titanium assembly of some complexity that contains fusion welded joints of considerable length that were made without adding any filler rod. In addition, this assembly contains a number of other joined parts. These include a hot spun "Z" ring, several hot formed bathtub type parts, some of which have been contour fusion welded without rod added, and riveted fasteners. The part is used on a turbojet engine, saving considerable weight over the use of steel.

To date, the no-rod-added welds have been principally used on longitudinal tight butt joints made manually in commercially pure titanium 0.062 in. thick or thinner. However, with further work and the aid of new automatic welding devices, it is felt that these limits will be erased. It is also thought that the technique of welding without rod, either manually or automatically, will be suited to the welding of weldable titanium alloys as well as commercially pure titanium.

In addition to improved ductility, elimination of filler metal

BEND ANGLE TO FAILURE

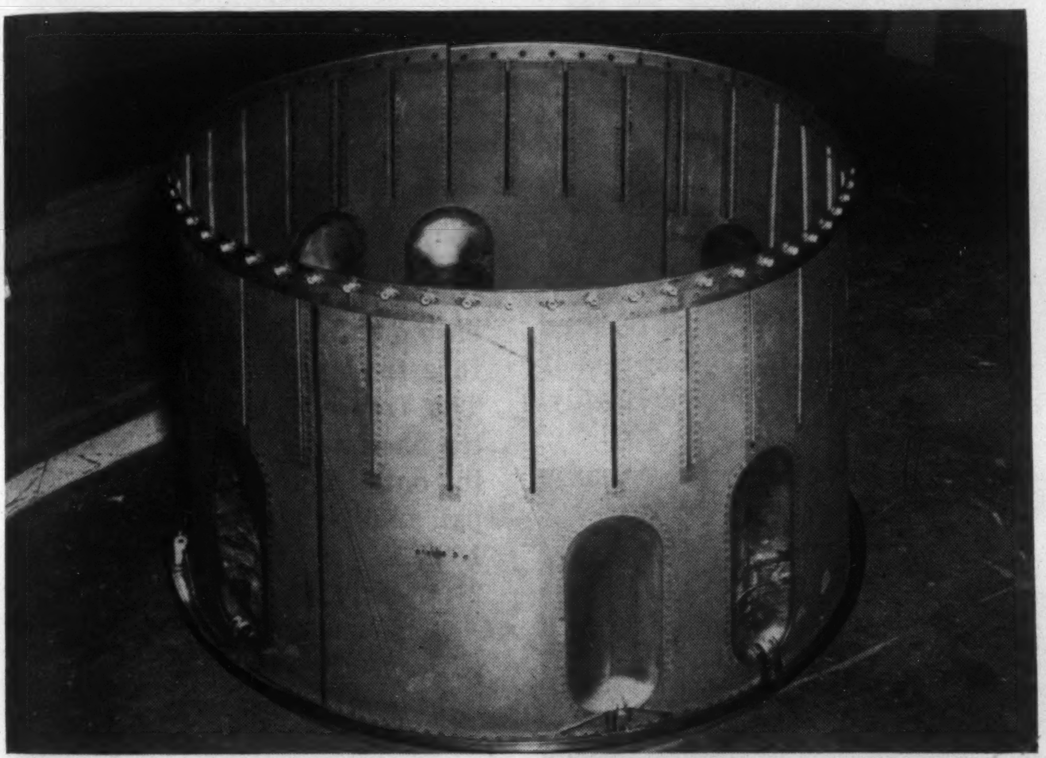
Sample History	Bend Parallel to Weld, deg (2T radius)	Bend Across Weld, deg (2T radius)	Bend at 45 deg. to Weld, deg (2T radius)
Welded With Rod	115	115	65
Original Test Without Rod	160	145	120
Final Test Without Rod	190	190	190
Base Metal	180	—	—

solved a number of grinding problems. These problems centered primarily around the severe grinding wheel wear associated with the operation and time necessary to remove the weld beads. Also, a tendency to overheat the metal at the joint resulted in localized embrittlement of the weld. The involved procedure required to remove the embrittled area and rework the part proved to be uneconomical, at best, and resulted in scrapping of the part in a few severe cases. The danger of embrittlement due to overheating during grinding operations was evidenced in one case by a sudden failure during a subsequent spinning operation. Eliminating the grinding operation considerably improved the quality of titanium parts.

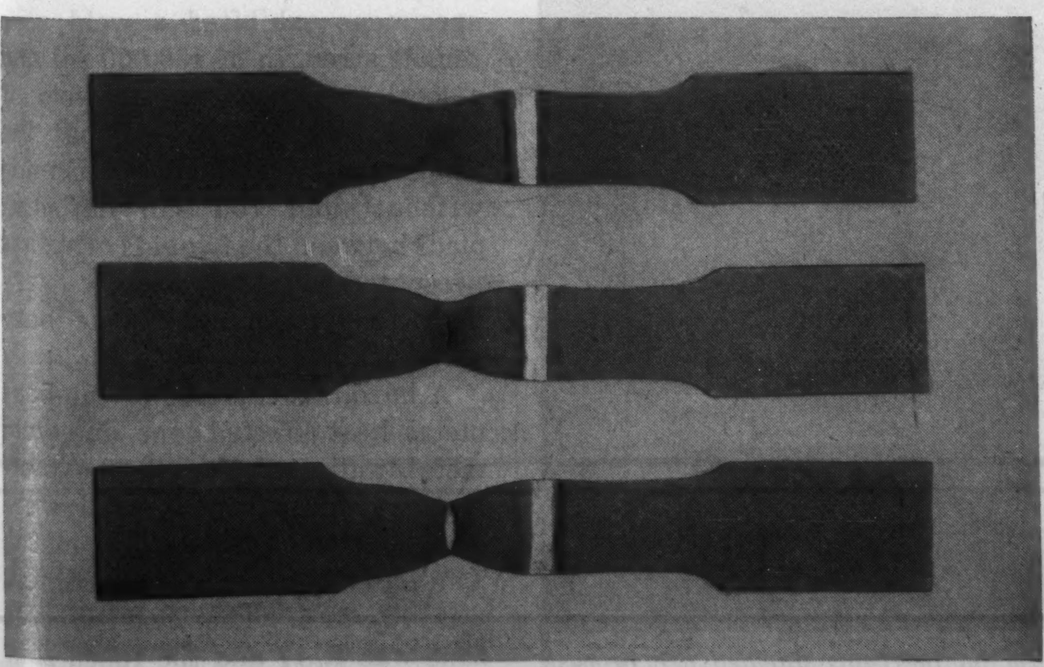
Weld ductility

The bend test of a sheet metal fusion weld is an excellent indication of its ductility. For the purposes of this investigation, the welded samples were bent over a 2T radius (T = metal thickness).

Table 1 is a summary of the bend test results. It can be seen that there is significant improve-



Complex titanium assembly *for turbojet welded without use of filler rod.*



Tensile strength *tests samples of titanium welded joints.*

Welding Conditions for Unalloyed Titanium

1. Welding equipment—Inert-gas-shielded arc welding equipment with 1/16 in.—2% thoriated tungsten electrode.
2. Back-up bar—0.5 in. thick mild steel bar with rectangular groove 3T deep by 3T wide where T is the thickness of the metal to be welded. 1/8 in. holes for argon back-up gas placed approximately 6 in. apart along the base of the groove starting 2 in. from the edge of the joint.
3. Hold-down bars—Mild steel bars 1/2 in. thick by 2½ in. wide chamfered on the weld side at 45 deg angle to 1/16 in. thick. Bars placed as close to the weld as possible and tightly clamped.
4. All metal should be either pickled in a 4% hydrofluoric acid, 40% nitric acid bath for 1-15 min until scale is visually removed or wire brushed with a stainless steel brush prior to welding.
5. Machine settings should be as low as is possible to produce a 100% penetration weld. For 0.040 in. titanium, settings should be: current: 25 amp; voltage: 25 amp. The welding is done on DC, straight polarity.
6. Argon flow through welding torch should be 12 C.F.H. for 0.040 in. titanium and should vary with metal thickness.
7. Argon flow for back-up groove should be 1-2 C.F.H. for each 6 in. of joint length for 0.040 in titanium and should vary with metal thickness.
8. Manual welding speed should be approximately 3 in. per min for 0.040 in. titanium.

ment in the ductility of a weld made with no filler rod added. Ductility is increased when the welding conditions under which the fused welds are made is improved. The accompanying pictures of test pieces show graphically the improvement in weld joint ductility made by welding without the addition of filler rod.

The ductility of a titanium fusion welded joint can be roughly determined by the surface color of the weld. This statement applies to original welds only, not to rewelds. The amount of gas contamination and resultant embrittlement in the weld is indicated by the thickness of the oxide layer that appears on the surface of the weld metal. As this oxide layer grows in thickness, it goes through a scale color phenomenon similar to that of steel. Table 2 lists these colors and the resultant bend angle to failure.

COLOR INDICATIONS OF WELD DUCTILITY

Weld Metal Surface Color	Bend < to Failure over 2T Radius
Silver	180 + (no rod added)
Silver	115° (rod added)
Light Straw	88°
Dark Straw	71°
Light Blue	66°
Dark Blue	21°
Gray Blue to Free Scale	0°

The fusion welding specification for titanium at Marquardt is written to limit acceptable fusion welds to those with a light straw color or bright silvery appearance on the weld metal surface only. A dark straw, blue or gray color or free scale on the surface is cause for rejection of the weld and part. It has been found that the bright silvery appearance is much easier to obtain when no weld rod is added. All bend test comparisons made in this paper, whether with rod or without, are made with welds that had a bright silvery appearance.

The major improvement realized by welding without the addition of filler rod can be explained readily. The loss of ductility in the weld joint is due, in part, to the absorption of gases such as oxygen, hydrogen and nitrogen into the weld metal from the air. These gases become interstitial alloying elements that decrease ductility of the resulting joint. Use of filler rod extends a path for the air to penetrate the argon blanket around the weld puddle and contaminate the weld. Eliminating the rod enables the blanket to remain unbroken and more effectively protects the molten surface of the metal. The reduction in contamination from surrounding atmosphere is the principal cause for improvement in the weld ductility. In addition, the oxide layer on the rod, another source of weld contamination, is eliminated.

Strength and hardness

Since the weld metal is stronger than the base metal, a standard sheet metal weld test does not indicate the actual strength of the weld. As can be seen in figure, the base metal necks and fractures before the weld metal or weld zone. The fracture strength is that of the base metal, in this case averaging out to a yield strength of 84,500 psi, an ultimate tensile strength of 102,500 psi and an elongation in 2 in. of 18.5%.

Some tests made on fusion welds with weld metal added, cast some light on the performance of the weld zone itself. The specimens were pre-necked at the weld zone and then tested to fracture. These specimens exhibited a weld zone tensile strength of 130,000 psi and a local elongation at the weld of about 8-10%. It is felt that the properties of a fusion weld made without filler rod will lie some place between the two sets of values presented above, probably very near the properties of the base metal.

A hardness traverse of the base metal, heat effected zone, and weld metal, indicated that the heat effected zone and weld metal were slightly softer than the base metal. The base metal average hardness was R_C 21.5. The heat effected zone was R_C17 and the fused zone was R_C19.

P&H
AC-DC ARC WELDER AC-DC

Welding setup *used for joining titanium by inert-gas-shielded arc process without adding filler metal.*

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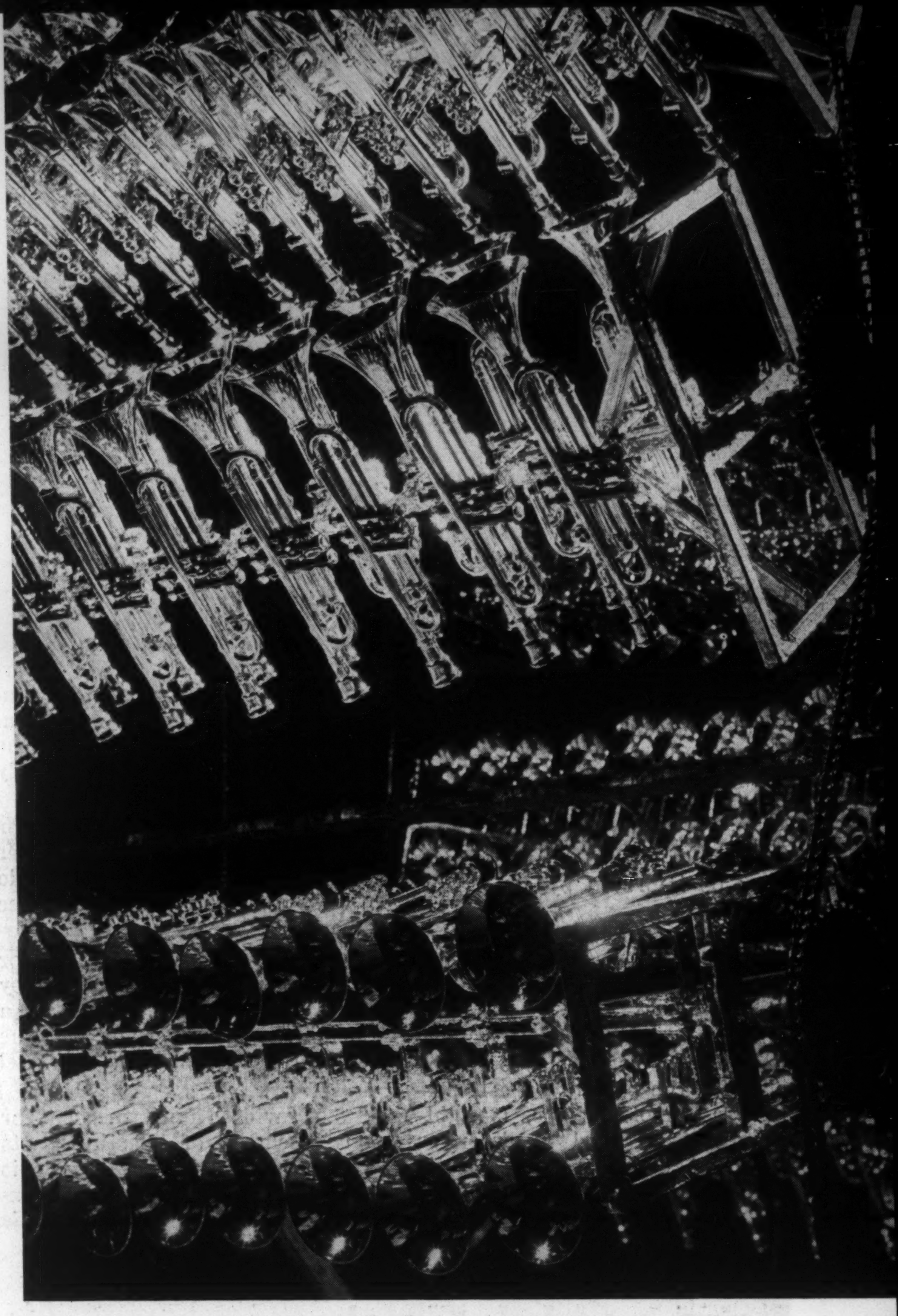


Polystyrene *toy trumpets, vacuum metallized with aluminum, are spun on this rig to obtain even drying of the protective lacquer overcoating.*

(Ideal Toy Corp.; F. J. Stokes Machine Co.)

Finishes for Plastics

by John B. Campbell, *Associate Editor, Materials & Methods*

This manual describes the paint, ink, metallic and other coatings used on plastics. It tells what types of finishes are available, how they can be applied, what advantages they offer, and what limitations must be considered. It also tells what types of finishes should be considered in trying to achieve specific functional advantages or decorative effects. In short, this manual gives the product designer the kind of information he needs for intelligent design of a plastic part or product. Major sections are:

- *Why a Finish?*
- *Paint and Ink Finishes*
- *Metallic Finishes*
- *Selecting a Finish*

MATERIALS & METHODS

MANUAL No. 116

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

Why a Finish?

■ A ready-finished surface and molded-in color—"color that won't rub off"—have long been cited as major advantages of plastics compared to wood and metal. Yet, the fact is that many of today's plastic products, like most metal products, carry "finishes"—faces that are not their own.

Finishes for plastics serve many different purposes, but primarily they are either functional or decorative.

A functional finish is one intended to provide a product with surface properties that it needs but does not otherwise have. For example, the solvent resistance, chemical resistance, water resistance, abrasion resistance or electrical characteristics may not be all that are desired in a plastic material that has been selected mainly for its strength and its moldability. Such characteristics may be improved by an organic coating.

Similarly, a certain type of metal surface may be preferable to a plastic surface because it is harder, more abrasion-resistant, more reflective or more conductive. Yet a plastic may be desirable for the part because it permits a complex shape, is lightweight, is a good insulator or does not corrode. In a plastic with a metal finish, all of these properties can be combined to a considerable degree.

A decorative finish is one intended to enhance the appearance of a product. It may:

1. Add contrast and variety; depending on the nature of the product; it may take not just color, but many colors attractively arranged, to catch and please the eye of the purchaser, particularly in the consumer market.

2. Identify the product, its brand name or its manufacturer; such finishes might be considered primarily functional, but in this article they will be considered decorative because of the important part played by aesthetic considerations, and because the materials and processes used are the same as those used for purely decorative finishes.

3. Provide letters, numerals or other marks related to the proper use of the product, as in radio tuners and instrument dials (see above).

4. Provide an appearance or color that cannot be provided by the base material, such as a metallic appearance or, in the case of phenolics, light or pastel colors.

5. Provide a uniform color for an assembly of plastics parts where an exact color match is difficult to achieve; a good example is the reinforced-plastic sports car body in which the different parts may be molded with different batches of materials, by different molding techniques, at different times and by different molders.

6. Hide surface blemishes or discoloration caused by such things as mold defects, materials of limited moldability, low molding pressures, or adhesive bonding of parts in an assembly.

7. Hide a natural surface pattern that may be undesirable for the particular application, such as the fiber pattern in glass-reinforced plastics (although integrally-molded gel coats or overlays are more widely used for this purpose).

A variety of finishes are available to meet these functional and decorative purposes. This article describes both the finishes and the methods by which they can be applied. It underlines the advantages and limitations of the different finishes, points out special problems that may be encountered in operation, and indicates which finishes should be considered to achieve a specific functional purpose or decorative effect. In short, this article is intended as a guide to the product designer who may find it desirable or necessary to specify finishes for plastics.

Paint and Ink Finishes

The most widely used finishes for plastics are lacquers, enamels and printing inks.

Inks are applied by printing methods solely for the purposes of decorating, identifying or providing information related to the proper use of a product. Suitable inks are available for most materials in a broad range of opaque and transparent colors. The exact formulation of an ink depends not only on the material to be printed, but also on the method by which it is to be printed. Some methods require faster-drying inks than others. Inks are air-drying, although heat is sometimes used to accelerate drying, especially in multicolor work or where a protective coating is to be applied. Even temporary swelling of the plastic surface must be avoided in rapid multicolor work if correct registration is to be achieved. A fast-drying ink finish is not very durable, and most inked patterns are protected by an overcoating of clear lacquer or an overlamination of transparent film. Where an ink finish is to be illuminated from the reverse side, as on internally lighted signs, a printed pattern may be transparent enough to require double printing for desired opacity. Much of the following discussion on paints applies equally to inks.

Paints may not only provide a color contrast for the purposes of decoration, identification or information, but also certain improvements in the functional surface characteristics of a plastic part. Ordinarily, however, the chief purpose of paints on plastics is decoration or identification, and other benefits are incidental.

Most paints for plastics are of the resin-solvent type, although emulsions are sometimes used. Resin-solvent paints can usually be classified either as lacquers or as enamels.

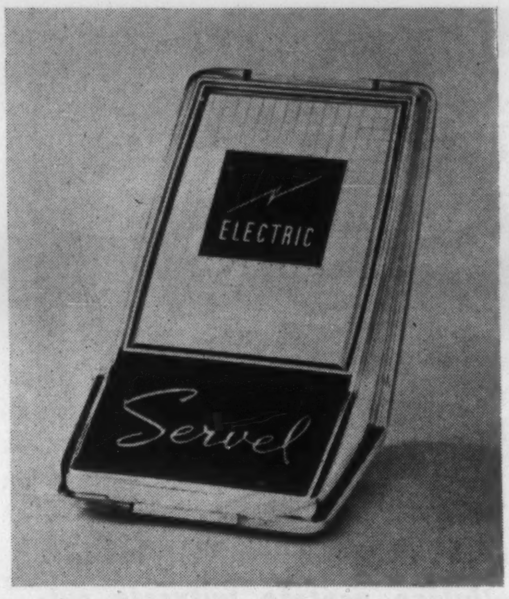
First or Second?

Two specialized terms widely used by molders have been used in this article for the sake of brevity:

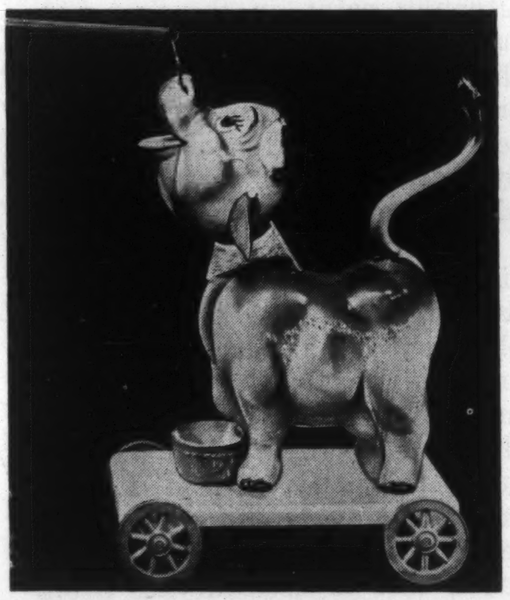
A *first surface* is a "front surface" of a molding or sheet that may be either transparent or opaque. A first-surface finish is simply a finish that is intended to be seen from the same side of the molding or sheet as that on which it is applied.

A *second surface* is a "back surface" of a transparent molding or sheet. A second-surface finish is intended primarily to be seen through the transparent plastic from the other side, although it may also be decorative when viewed as a first-surface finish.

Polyethylene *containers, squeezable and otherwise, decorated by offset printing or silk screening.*
(Millsplastic Div., Continental Can Co.)



Acrylic *refrigerator door handle decorated on second surface by combination of spray-painting and vacuum metallizing.*
(Servel, Inc.; Rohm & Haas Co.)



Polystyrene *toy decorated by spray-painting.* *(Alladin Plastics, Inc.)*

Vinyl *table cloth decorated by gravure printing.*
(Weiss & Klau Co.; Bakelite Co.)

A lacquer is essentially a solvent solution of a thermoplastic resin, with or without pigment. It dries solely by evaporation of solvent. Many lacquers air-dry rapidly; others are often heated to reduce drying time ("force drying"). The dry film consists simply of the original thermoplastic resin. Common film-formers are the polymers of cellulose nitrate, cellulose acetate, ethyl cellulose, methyl methacrylate, vinyl chloride and vinyl acetate.

An enamel is essentially a solvent solution of a thermosetting material, usually with pigment. Evaporation of solvent leaves a relatively soft film which must then be oxidized and/or polymerized to form a hard, durable film. In high-quality enamels, this chemical reaction requires fairly high baking temperatures, although air-drying and low baking enamels that cure primarily by oxidation are also available. Enamels are usually based on alkyd or oil-modified alkyd resins, often modified with urea- or melamine-formaldehyde resins for improved hardness and light stability.

Enamel films generally have higher gloss, higher hardness and greater solvent resistance than lacquer films. Enamels are also less costly to spray because of the higher solids content permitted and the less expensive solvents required. On the other hand, the baking temperatures required by high-quality enamels are too high for thermoplastic parts; consequently enamels are used primarily on thermosetting plastics. Lacquers may be used not only on thermoplastics, but also on thermosetting plastics where rapid air-drying is necessary or where it is desirable to reclaim poorly-painted parts (lacquer films can be readily dissolved but enamel films are relatively insoluble).

An important factor in proper paint selection is the type of service required of the applied film. Cellulosic films are often adequate indoors, although vinyls or modified alkyds are usually required for parts exposed to grease and food acids. For outdoor exposure, acrylic, pigmented nitrocellulose or pigmented alkyd paints are generally required for adequate resistance to weathering and sunlight. A paint often has better surface properties than the plastic to which it is applied, but protection afforded by a thin paint film is generally not enough to warrant use of the plastic in an environment in which it would ordinarily be unsuitable.

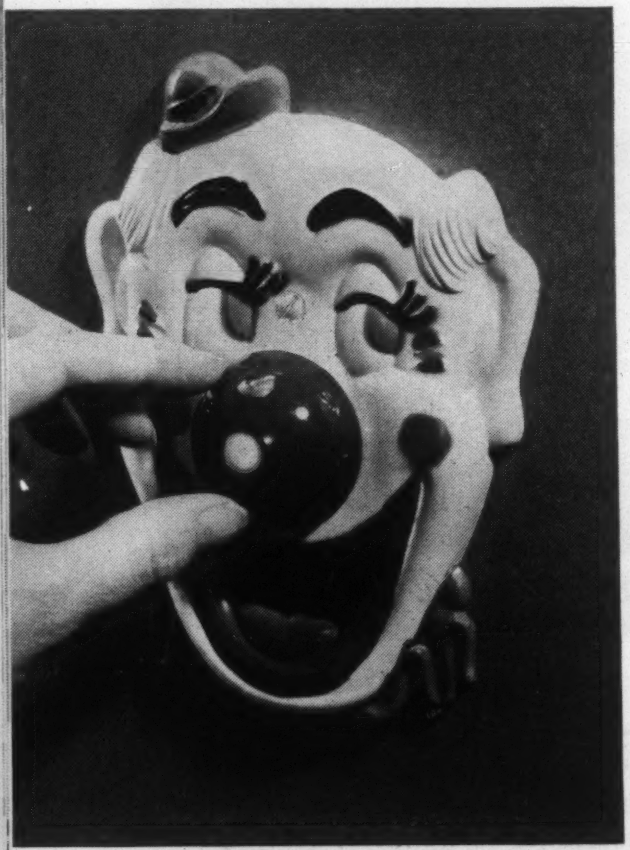
Selection of paints for plastic sheet materials must sometimes take into consideration the forming conditions. Paints for sheet that is to be hot-formed must be sufficiently heat-resistant to withstand the forming temperature and flexible enough to withstand any stretching required.

Paints for plastics are avail-

Refresh with...
Welch's
or
Sunkist
they're better for you!

Cellulose acetate butyrate *outdoor sign was decorated prior to vacuum forming by a combination of spray-lacquering and silk screen printing.*

(Eastman Chemical Products, Inc.)



Cellulose acetate *switch plate may be made by injection molding and spray-lacquering, or by vacuum forming of sheet pre-decorated by silk screening.*

(Falcon Plastic Products, Inc.; Eastman Chemical Products, Inc.)

able clear and opaque in a broad range of standard colors. Most common are the pigmented, metallic and pigmented metallic types. Special decorative types such as iridescent, simulated pearl, spatter and stipple finishes are available. Lacquers and enamels that provide electrically conductive surfaces or surfaces of controlled electrical resistivity ("resistor paints") are available.

Painting problems

Many of the problems encountered in metal finishing are also encountered in painting plastics. In addition, problems peculiar to plastics sometimes arise. Most important are:

Etching — Certain solvents attack thermoplastic surfaces causing a rough or frosty appearance called "etch". Many lacquers for thermoplastics depend upon etch for adhesion. However, it has been shown that a visible etch is not always necessary, and there are several reasons why a visible etch should be avoided wherever possible. First, a visible etch means that overspray cannot be tolerated. Second, although paint on the first surface tends to hide an etch, even the slightest etch is easily visible on the second surface. Third, severe etch is often accompanied by a color change, particularly in pigmented metallic paints.

Sometimes, especially on plasticized materials and where the paint resin is quite similar to the plastic, it is hard to avoid use of an etching solvent. Addition of inactive thinners may reduce or eliminate etch. Water also reduces the activity of a solvent, and a highly humid atmosphere tends to reduce etch. In both cases, care is necessary to avoid throwing the resins out of solution and producing "humidity blush" with consequent loss of adhesion.

Crazing—The term "crazing" refers to the formation of distinct surface cracks or minute, frost-like internal cracks where the cohesive strength of a plastic has been exceeded by local stresses. Polystyrene is particularly subject to crazing. Parts that are craze-free may nevertheless be highly stressed as a result of molding and cooling conditions, and swelling caused by absorbed paint solvents may increase local stresses enough to cause crazing. Within limits, crazing can be reduced by adding less active solvents to the paint or replacing an active solvent with a less active solvent, thereby reducing the amount of solvent absorbed by the plastic. Sometimes a very active solvent can be used on a highly stressed part; apparently it soaks in uniformly and to such an extent that stresses are relieved and rupture does not occur. The best way to prevent crazing due to painting, however, is to paint only parts that have been either molded with little stress or subsequently annealed to remove stress.

Plasticizer migration—Plasticizer, usually present in plastics such as vinyl and acetate, tends to migrate to the surface and may soften the paint film. Softening may occur some time after painting—even after the products have been shipped. An accelerated test for plasticizer migration can be made by exposing a painted specimen in a humidity cabinet for 72 hr at 100 F and 80% relative humidity, and observing whether softening or loss of adhesion occurs. Paints that will tolerate plasticizer without significant loss of properties are available. Plasticizer migration can also be minimized by using paints having film formers in which the plasticizer is less soluble than it is in the plastic itself.

Solvent absorption — Plastics such as highly plasticized vinyl, cellulose acetate and cellulose acetate butyrate absorb certain solvents rapidly, yet cause no visible etch. Excessive absorption has two effects. First, it makes the paint film immobile too quickly, thus reducing flow-out. Poor flow-out produces an uneven finish and, in silk screening, may cause a severe screen pattern to remain in the paint film. Second, it lengthens drying time considerably, since the solvent must migrate back through the plastic and the paint film before it can evaporate. A painted sheet or part may appear to be dry, yet stick to its package or another part in stacking or packaging. Sticking or "blocking" can be reduced by adding inert fillers to the paint, but gloss will suffer.

The sections "Painting problems" and "Effect of material" were contributed by Lloyd E. Parks, vice president, Logo, Inc.

Effect of material

Plastics vary in physical and chemical properties and the variations are sufficient to affect the type of paint required.

A satisfactory paint for a plastic must adhere to it through mechanical bonding, intermolecular attraction, or preferably both. Mechanical bonding is usually achieved through attack on the plastic surface by the paint solvents. Where drying time is exceptionally short, as in some rapid printing methods, mechanical bonding can be improved by printing on matte surfaces instead of glossy surfaces.

Intermolecular attraction, often referred to as "van der Waals' forces" or "specific adhesion", seems to depend a great deal on polarity. For a given average molecular size, highly polar materials have greater attraction for each other than for non-polar materials, and vice versa. A highly polar resin tends to be soluble in polar solvents and insoluble in non-polar solvents. Similarly, a non-polar resin tends to be soluble in non-polar solvents and insoluble in polar solvents.

For the purpose of this discussion, the more important plastics have been divided into three groups: two groups of thermoplastics, plus the thermosets. Resins of the first group of thermoplastics are similar in that the basic polymers are essentially linear arrangements of ethylene and substituted-ethylene units.

Polyethylene is a high-molecular-weight aliphatic hydrocarbon made by the polymerization of ethylene. It is symmetrical and non-polar and therefore might be expected to be soluble in non-polar solvents. Actually, because of its high molecular weight, it has good chemical resistance to both polar and non-polar solvents at room temperature. At 40 F it is attacked by non-polar hydrocarbons and chlorinated hydrocarbons of low polarity.

Untreated polyethylene is difficult to paint or print. Its solvent resistance prevents mechanical bonding of a resin film; its non-polar characteristics do not favor adhesion through intermolecular attraction, and its chemical inertness prohibits paint adhesion through primary valences.

However, certain resins do have good adherence to polyethylene if its surface properties are changed by one of several special treatments. Surface oxidation by means of irradiation or vapor phase chlorination has been successful. More widely used is the Kreidl Process in which the surface is exposed to a stream of extremely hot, slightly oxidizing gases. The exact nature of the surface change is subject to controversy, but oxidation, changes in orientation and changes in crystallinity appear to be involved. Since most polyethylene products must withstand considerable flexing, handling and contact with liquids, a special surface treatment is applied to virtually all polyethylene that is to be decorated.

Alkyd resins are used in finishes for treated polyethylene and paint solvents can be selected quite freely since the treated plastic is still inert and will not be affected by solvents. Light stability is not required in polyethylene paints, since the plastic itself does not have stability to ultraviolet light.

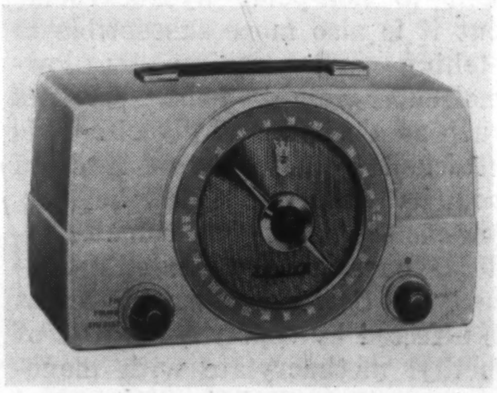
Polystyrene differs from polyethylene by the substitution of one phenyl group on each ethylene unit, making the polymer unsymmetrical and thus slightly polar. Polystyrene is attacked by solvents such as aromatic hydrocarbons, chlorinated hydrocarbons and esters, but has good resistance to more polar solvents such as the lower alcohols, glycols and water. It may be crazed by acetone, the lower aliphatic hydrocarbons and the higher alcohols.

The chemical activity of polystyrene makes it rather easy to paint. Solvent attack is sufficient to cause mechanical bonding of the paint film to the plastic and polarity appears sufficient to cause adhesion through van der Waals' forces. A number of paints having good adhesion to polystyrene and properties superior to polystyrene are available. Resins such as cellulose acetate, ethyl cellulose, acrylics, alkyds, ureas and a number of base gums are used in finishes for polystyrene. Many combinations of alcohols, esters, ketones and hydrocarbons are used; however, solvents must be blended to avoid noticeable attack of the plastic surface.

Normally, the small amount of internal lubricant sometimes used in polystyrene does not affect paint adhesion; however, stearates tend to be incompatible with the plastic and with paint and may cause trouble when present in excessive amounts. Adjustment of the paint formulation may be necessary for polystyrene that has been modified by copolymerization with other monomers or by mechanical mixing with other polymers.

Polyvinyl chloride differs from polyethylene by the substitution of a chlorine atom on each ethylene unit making the polymer unsymmetrical and polar. Vinyls are attacked by ketones, esters and chlorinated hydrocarbons, but are resistant to non-polar solvents such as hydrocarbons and polar solvents such as alcohols.

Paints adhere to vinyls by mechanical bonding and intermolecular attraction. However, the specific properties of each vinyl formulation must be considered in selecting a paint. The copolymerization of vinyl chloride with vinyl acetate increases the degree of dissymmetry and polarity of the polymer, thereby affecting the solvency of the resin. Flexible sheet, the most widely decorated form of vinyl, is loaded with plasti-



Phenolic *radio cabinet and calculator housing decorated by spray-painting. Calculator housing has a baked wrinkle finish.*

(Zenith Radio Corp.; Auburn Button Works)

cizer; it is necessary that the paint film tolerate this plasticizer without softening or loss of adhesion, and that precautions be taken against excessive solvent absorption. Lubricants used in thin sheet to prevent sticking in the processing equipment also have poor compatibility with vinyl and collect on the surface to cause paint adhesion problems.

Plasticized vinyl resin formulations are widely used as finishes for vinyl to establish plasticizer equilibrium and avoid changes in properties due to plasticizer migration from the plastic. Ketones and esters are commonly used as solvents. Fast-drying formulations are particularly important, since much decoration of vinyls involves silk screening or printing on sheet.

Polymethyl methacrylate differs from polyethylene by the substitution of a methyl group and a carbmethoxy group on one carbon of each ethylene unit in the polymer. It is more polar than polystyrene and therefore more resistant to non-polar hydrocarbons, but it is also more susceptible to etching and crazing by low-molecular-weight polar solvents such as alcohols and glycols. It is attacked by solvents of medium polarity such as esters, ketones, low-molecular-weight aromatic hydrocarbons and chlorinated hydrocarbons. Solvency of acrylic resins is affected by copolymerization of methyl methacrylate with monomers such as methyl acrylate and ethyl methacrylate, and by variations in molecular weight.

Resins such as acrylates, nitrocellulose, alkyds, ureas, melamines and many base gums are used in paints for acrylic plastics. Hydrocarbons, ketones, esters, and alcohols are used as solvents. The carbmethoxy group adds light stability to acrylics making them quite superior to polyethylene, polystyrene or polyvinyl chloride for exterior exposure. Consequently, acrylics are widely used for outdoor applications and therefore require paints extremely durable on outdoor exposure.

The second group of thermoplastics differs basically from the first group in that the resins are long chains of glucose units rather than ethylene units. Differences among the individual cellulosics are based on the types of groups substituted for the hydroxyl groups of the glucose.

Cellulose acetate is quite polar and is resistant to non-polar aliphatic and aromatic hydrocarbons. It is attacked by solvents of medium polarity such as ketones, esters and chlorinated hydrocarbons, but is resistant to the more polar alcohols because of its high molecular weight.

Paint adhesion can be obtained through mechanical bonding and van der Waals' forces. However, the amount and type of plasticizer must be considered in selecting a paint. In general, the resin in the paint must be similar to the plastic and must not be softened appreciably by plasticizer migration. The solvent system must be carefully balanced to avoid excessive etching and also excessive solvent absorption which, especially on thin sheet, may cause curling and warping.

Cellulose acetate butyrate differs from cellulose acetate in that longer-chain butyrate groups have been substituted for some of the acetate groups. The molecule is still polar, but the butyrate group makes the resin more soluble or at least changes the rate of solvation by certain solvents.

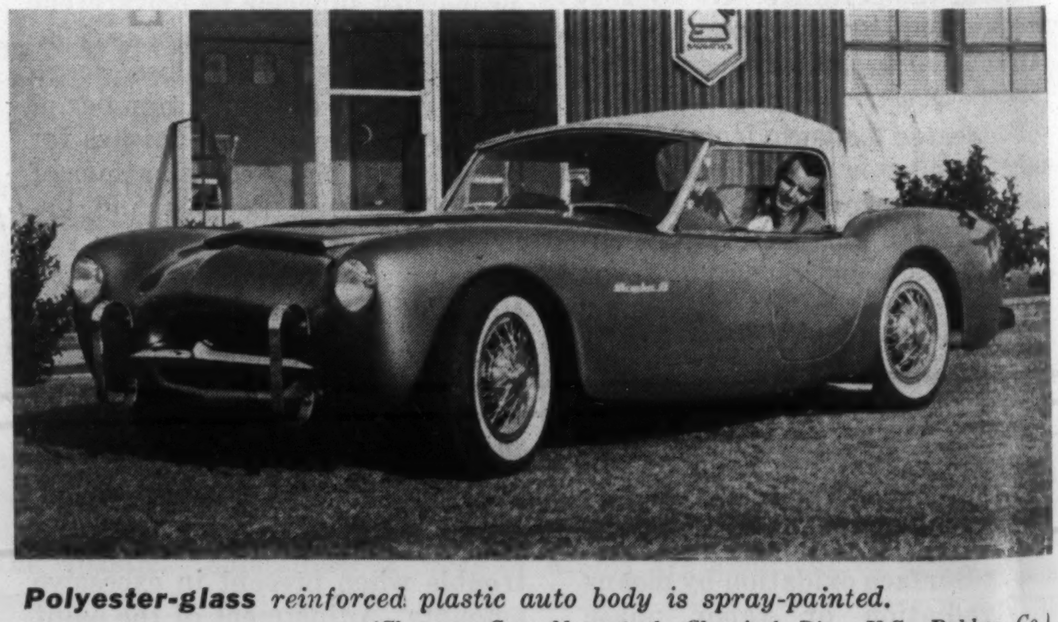
Although butyrate requires less plasticizer than cellulose acetate, there is enough plasticizer in most butyrate formulations to require consideration in paint selection. Since the applications of butyrate are somewhat similar to those of acetate, paint requirements are generally about the same. However, the recent formulation of light-stable butyrate and its increasing use in the fabrication of outdoor signs has placed increased emphasis on high-quality finishes with good moisture resistance, light stability and all-around outdoor durability equal to that of light-stabilized butyrate itself.

Ethyl cellulose differs from cellulose acetate and cellulose acetate butyrate in that it is an ether rather than an ester. Hence, it is less polar and is attacked by gasoline. The resin is polar enough to be reasonably easy to paint but, as with the other cellulosics, the presence of plasticizer and other additives must be considered in paint selection.

The third group of plastics, the thermosets, consist of cross-linked molecules rather than linear molecule chains. These plastics are quite resistant to solvents and do not soften or change when subjected to relatively high temperatures.

Phenolics can be painted with baking enamels; baking temperatures slightly higher than 300 F can be tolerated, although temperatures below 275 F are recommended to reduce warping and blistering. Tough enamels based on various combinations of alkyds, ureas and melamines have good adhesion to phenolics, and paint solvents of any type may be used.

Polyesters are normally reinforced with glass fibers, mat or cloth. Like phenolics, polyesters can be painted with baking enamels where service conditions make such a finish desirable. However, the presence of air or solvent trapped by reinforcing



Polyester-glass *reinforced plastic auto body is spray-painted.*

(Glasspar Co.; Naugatuck Chemical Div., U.S. Rubber Co.)

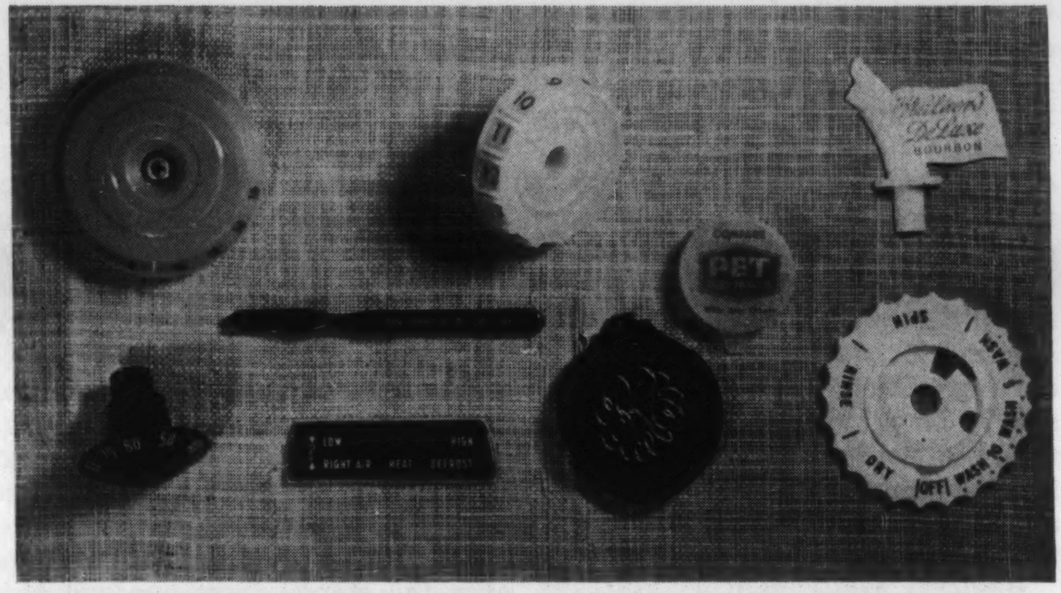
glass fibers and by surface irregularities due to low molding pressures can result in blow-holes when heat is applied to cure enamels. This problem has been reduced somewhat with the recent development of techniques for obtaining improved wetting of glass fibers by the liquid resin. Primer coats are often used to fill surface irregularities and cover exposed glass fibers. The problem can be avoided by using air-dry lacquers and enamels where such finishes are satisfactory for the service conditions expected.

The surface—To be painted satisfactorily, a plastic surface must be clean so that adhesion is not inhibited by incompatible materials. If a glossy finish is desired, the surface must also be relatively smooth.

The most common contaminants on plastic surfaces are lubricants of various types. They may be stearate or silicone mold lubricants, internal lubricants added to the molding formulation for better flow, or oil that has been trapped in the spray line or deposited from the surrounding atmosphere.

Small amounts of stearate can be removed by solvents that are inactive toward the plastic, but silicones and excessive amounts of stearate are extremely difficult to remove. A certain amount of residual lubricant can be tolerated by non-grease-resistant paints, and such formulations may be used if a high-quality film is not required. Generally, mold lubricants should be used sparingly for parts to be painted. Need for lubricants can often be eliminated entirely through proper design and finishing of the mold. Solvents used to remove lubricants must be completely evaporated from the surface before painting.

The amount of mechanical finishing required to produce a surface suitable for a glossy paint finish depends upon prior processing conditions. Film, "glossy" or "press-polished" sheet, and parts made in highly-polished molds generally require little or no mechanical finishing prior to painting. Parts made in lower-quality molds and reinforced plastics, which are molded at low or contact pressures, may require a sequence of polishing operations prior to painting.



Thermoplastics *are often decorated by hot stamping with roll leaf.*
(Peerless Roll Leaf Co.)

Where it is hard to obtain adequate adhesion, a matte plastic surface is preferable to a glossy plastic surface. Adhesion of fast-drying inks can be improved by printing on unpolished or blast-finished sheet; then press polishing, over-lacquering or over-laminating to provide a glossy finish. Slightly roughened surfaces are sometimes desirable on moldings; they may be incorporated in the mold or produced by light sanding or etching.

Application methods

Paints and inks are applied to plastics in many different ways. The method depends primarily upon the form and size of the material or part, the size and shape of the area to be covered, the number of colors desired, the production quantities and rates required, the quality desired and, of course, the equipment or suppliers available.

Spraying—Spray gun application is suitable for parts of virtually any size, although extremely small parts must be carefully racked to avoid excessive loss through overspray. Spraying is suitable for almost all exterior surfaces, but not usually adequate for interior surfaces. Multicolor designs can be applied by successive spraying operations.

Spraying is a rapid method for coating parts, and is quite economical for intermediate and large quantities. Speed and economy can often be improved by using masks to partly or wholly eliminate the need for removing overspray from areas where paint is not desired. For small quantities, cost of spraying depends considerably on whether close-fitting masks are required. The cost of masking itself varies widely with both part design and color design. The effect upon masking requirements of such factors as contours, radii, continuity of decorative designs and demarcation of colors should be carefully considered by the product designer.

A high-quality sprayed finish requires some skill in application. Distance of the spray gun from the surface is important. If the gun is held too close, the coating will be too thick and too solvent-laden. Too much solvent not only increases drying time but also results in excessive attack on some plastics. If the gun is held too far away, too much solvent may evaporate and the paint will not have enough "bite" for proper adhesion. For some materials, particularly polystyrene, the solvent balance in the lacquers is so sensitive that little latitude in spray gun distance is permitted.

Brushing—Brushing is suitable for parts of any size but is seldom used for painting large areas, since it is slower and more expensive than spraying. Brushing is ordinarily limited to small areas, especially for "wipe-in" coatings or where more than one color is to be applied. For such work, brushing may be much less expensive than mask-spraying. Fast-drying, high-quality brushed finishes can usually be obtained from formulations similar to spray types but of lower viscosity.

Dipping—Dipping is suitable for parts of almost any size and is used primarily on parts to be entirely or almost entirely painted. Almost any shape can be satisfactorily dip-coated, and dipping may be the only satisfactory way of painting certain interior surfaces. However, it is usually not possible to obtain uniform thickness on complex shapes. Dipping is ordinarily used for single-color applications. For reproducible coating thicknesses, the part should be removed from the dip tank at a controlled rate. Mechanical dipping is therefore preferable to hand dipping for any but the smallest quantities.

Roller coating—Roller coating is used primarily to coat the surfaces of raised one-plane designs on parts. Ordinarily this technique is less expensive than masking the background and spraying the design. Paints for such applications must have relatively high viscosity to avoid flowing into the background.

Silk screening — Silk screen printing is especially adapted to multicolor designs on intermediate- to large-size parts, as well as sheet and film. Silk screening is usually applied to flat surfaces, although patented methods for curved surfaces have been developed. Silk screen stencils can be prepared so that a design applied out of registration on flat sheet will be in proper registration when the sheet has been formed.

For complex multicolor designs, silk screening is much less expensive than spraying, considering the extensive masking that would be required. Typical production rates range from 250 to 500 parts per hour by hand, and from 400 to 1000 parts per hour with a mechanical printer. Silk screening is much slower than letterpress printing for flat surfaces, but it is much less expensive for limited quantities.

Silk-screened coatings are usually thick, and colors tend to be rich and non-glossy. The solvent balance in a silk screening formulation must be adjusted so that the paint will dry slowly enough to permit continued operation on the screen, yet not so slowly that drying time of the printed surface is unnecessarily long. The solvent balance must also provide enough flow-out to obliterate the screen pattern, but not enough to blur the demarcation line between different colors. Solvents too readily absorbed by the plastic must be avoided, not only because of the longer drying time they cause, but also because they make the film harden prematurely, leaving a severe screen pattern.

Silk screening requires little initial investment, particularly if stencil preparation is contracted to specialists in that work. Principal equipment required includes a screen and frame, a rubber squeegee and a separate stencil for each color. Silk screening is done by laying the screen over the surface and squeegeeing ink or paint over the stencil from one end of the frame to the other. Screen mesh and consistency of the squeegee are important factors in determining finish quality.

Offset printing—Offsetting from type or relief plates is the most common way of printing on plastic sheet where more than 10,000 impressions are required.

In offset printing, the type or plate impression is transferred to a rubber roll which in turn transfers it to the plastic surface. Hand-operated or large rotary presses may be used, depending upon production quantities.

Offset printing is also suitable for curved surfaces. In reproduction of photographs it is quite inferior to letterpress; however, offset tends to be less expensive than letterpress. It provides a smoother, more finely detailed, more delicate design than can be obtained by silk screening, hot stamping, etc. As in letterpress, two or more colors can be printed simultaneously so that difficulties in registration commonly encountered in silk screening are avoided. Offset inks are thick and slow-drying; printed sheets cannot be stacked but must be individually racked for drying.

Letterpress printing — Letterpress printing is generally suitable only for single- or multi-color patterns on flat sheet. It provides sharper, cleaner reproduction of lettering than any other printing method, and is equal to gravure printing in its reproduction of photographs. It is much faster than silk screen printing, but much more expensive for small quantities. Letterpress inks are generally similar to offset inks.

Gravure and flexographic printing — Gravure and flexographic printing are generally used only for single- or multi-color patterns on continuous film. In gravure printing, ink is transferred from depressed surfaces rather than raised surfaces as in letterpress or a plane surface as in offset. It provides high-quality reproduction of photographs and other half-tone illustrations, even on matte surfaces, but not such clear reproduction of type, especially in small sizes. Although the plates required are relatively expensive, the process is roughly comparable in cost to letterpress printing. Small runs, ranging from 10,000 to about 100,000 impressions, are generally handled on sheet-fed presses; larger runs of 250,000 and up can be economically handled on web-fed rotogravure presses. Flexographic printing utilizes rubber relief plates and is less expensive than gravure printing for small quantities. Inks for both methods are fast-drying, but drying may be further accelerated by heating in multicolor work.

Roll leaf stamping—Roll leaf stamping is widely used on small- and intermediate-size parts. It is suitable for flat, concave or convex surfaces, including round and tubular shapes. Production rates vary considerably depending upon the particular application and the equipment used.

In roll leaf stamping, roll leaf, consisting of color pigments or metal powders bonded to continuous tape, is pressed into the plastic surface by a hot male die. In addition to softening the surface, the applied heat softens the binder holding the pigment to the tape and allows it to be transferred to the imprint.

On thermoplastics, it is possible to imprint and emboss the surface simultaneously. Roll leaf can also be applied to an already-depressed surface by means of a matching male die, or to a raised surface by means of a hot silicone rubber pad ("dome printing").

Temperature, pressure and "dwell time" used in roll leaf stamping are interrelated and depend on the material, the depth of impression desired, the degree of clarity desired, and the size and shape of the part. Harmful stress concentrations can often be avoided by increasing temperature or time rather than pressure.

Temperatures and pressures required for thermosets are much higher than those required for thermoplastics, and thermosets are ordinarily not finished by this method. With care, however, fairly satisfactory results can be achieved. A thermosetting plastic part to be hot stamped must be relatively rugged in order to withstand the required heat and pressure. The stamping load must not be applied over a hollow part of the molding. Hard tool steel dies must be used and they must be deeply and sharply engraved. Recommended limits: 1/16 to 3/16 in. depth of pattern; 12 deg maximum draft; 1/32 in., or preferably 1/64 in., maximum width of face.

Since the temperature used in hot stamping depends on the particular material, the temperature at which the pigment is released from the tape must also vary with the material. In ordering roll leaf, therefore, it is just as important to specify the material to be finished as it is in ordering a paint. For thermosetting plastics, not only the binder but also the tape itself is different, since the tapes used for thermoplastics cannot withstand the higher operating temperatures required for thermosets.

Roll leaf stamping offers several advantages compared to painting a depressed surface. Imprinting and coloring are done rapidly and simultaneously. Two or more colors can be stamped on at the same time by using separate rolls for each, although fairly expensive tooling may be required. Since no drying time is required, finished parts can be packaged immediately. It has been estimated that roll leaf stamping costs only about one-third as much as painting in certain long-run applications. Patterns applied by roll leaf stamping, being recessed, are also more durable than other printed designs. On the other hand, roll leaf stamping is more expensive than silk screening for short runs.

Colors available include genuine gold, imitation gold, silver, aluminum and a full range of metallic and pigment colors. Most colors are available in 200-ft rolls and in widths from ¼ to 24 in. Genuine gold is available in 100-ft rolls and in widths from ⅛ to 6½ in. Most colors cost two or three cents per 100 sq in.; pure gold costs 35 to 50 cents per 100 sq in.

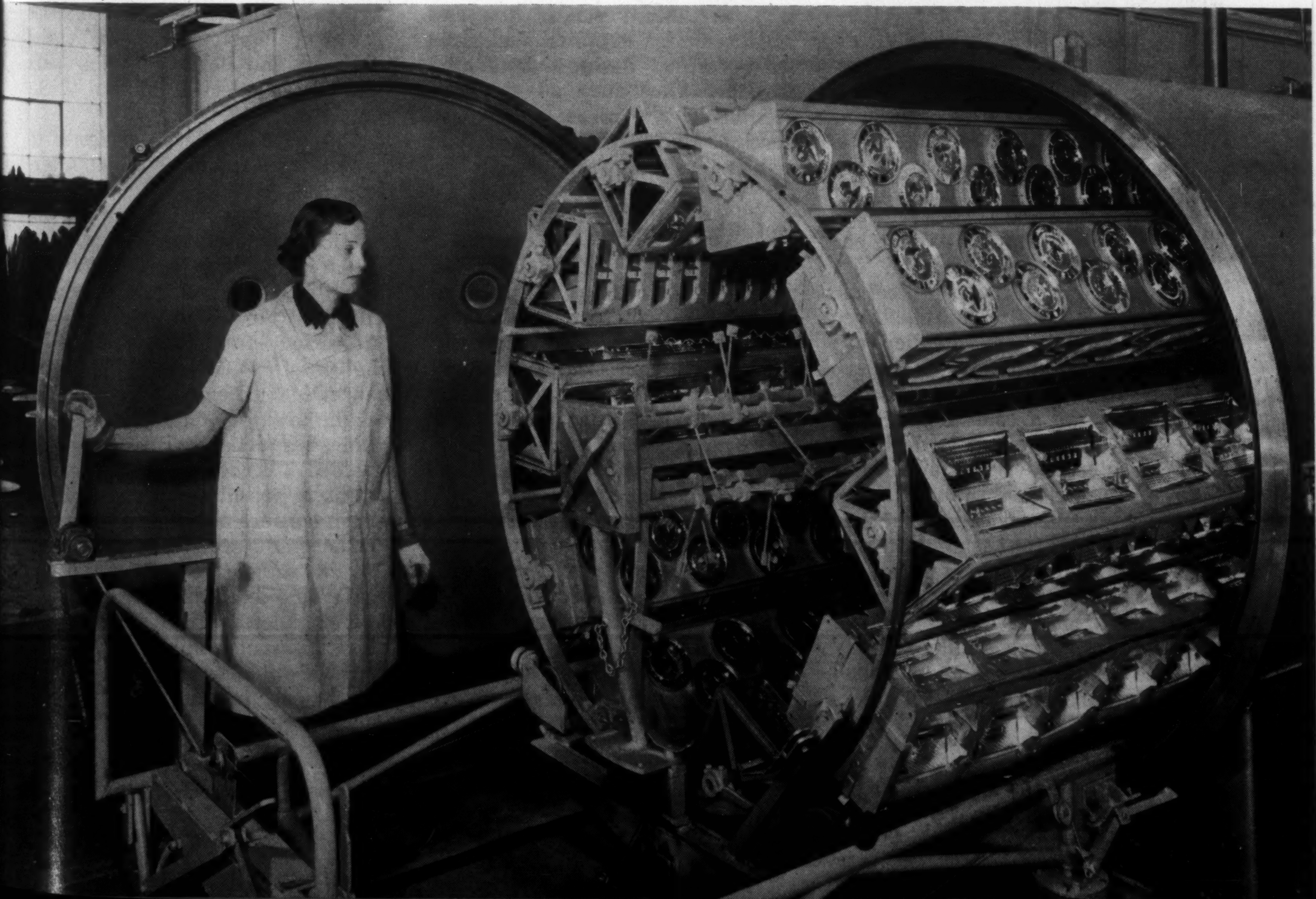
Special presses are available, although most platen presses can be fitted with a standard attachment for the roll leaf process. The machines can be equipped with various mechanical handling devices that compensate for any nonuniformity in thickness or shape of the parts.

Hot stamping — Ordinary hot stamping is similar to roll leaf stamping except that inks are applied directly. The hot type or die is inked with a felt roller and pressed into the plastic surface. A wide color range is possible, the process is less expensive than roll leaf stamping, and the breakage problem sometimes encountered with roll leaf is avoided. Ink stamping has been reported to be more effective than roll leaf stamping in certain applications, especially on thermosets.

Adhesive bonding — Adhesive-bonding of a pre-printed design is suitable for sheet, film or parts of any size. Although such designs theoretically are not limited in size, they are generally fairly small. They can be applied to flat and two-dimensional surfaces, but not to three-dimensional surfaces. Ordinarily the design is of several different colors. Since the inks are dry, it is not compatibility of the inks but compatibility

Acrylic *nameplates, medallions and compartment doors for Kelvinator refrigerators are vacuum metallized with aluminum on the second surface.*

(Plastics Dept., American Motors Corp.; F. J. Stokes Machine Co.)



of the adhesives with the plastic surface that is the important consideration.

There are two broad types of pre-printed designs: labels and decals.

A label consists of a pattern printed on paper, fabric or film. Some labels are applied by separate adhesives. Others have a pressure-sensitive adhesive coating that is protected by a backing tape up to the time of application. A special patented method utilizes labels printed on non-adhesive stock that is covered with a thin thermoplastic coating. These labels are applied directly to the surface and subjected to heat which melts the plastic coating over the edges of the label to secure adherence. Pressure-sensitive and heat-sensitive labels can be applied without the registration difficulties ordinarily caused by separate adhesives. They can be applied rapidly and are relatively inexpensive. However, decorative possibilities are limited, and labels are used primarily for product identification and informative purposes.

A decalcomania consists essentially of a pattern printed on a lacquer film which is bonded to a paper backing. The design may face toward or away from the backing, depending on whether the decal is to be applied to a first or second surface. Decals readable from both sides are also available. A decal is applied by pressing the printed lacquer film against the plastic surface and moistening it. The moisture releases the paper backing and activates the adhesive on the reverse side of the film. Decals suitable for all plastics are available. They should be applied on a smooth surface, although a preliminary slight etching treatment may improve adhesion. Although decals are relatively inexpensive, applying them is a slow process, and they should ordinarily be allowed to dry about 48 hr before appreciable handling.

Metallic Finishes

Although finishes having a metallic appearance and some metallic properties can be provided by paints containing metal powders, there are many applications, both functional and decorative, where pure metal films or strips are desirable. As functional coatings, they are used primarily to reflect light or to conduct electricity. As decorative films or strips, they are commonly used to enhance the luster of paints or to stimulate solid metal. Films of all common metals can be successfully deposited on virtually all plastics although much difficulty may be encountered with heavily plasticized materials such as flexible vinyl film and sheet. Also, strips of metal can be inlaid in any plastic surface ("metal inlaying").

A thin metal film that is to be subject to impact, abrasion or other abuse is usually protected by a clear lacquer that must be compatible with the plastic (or with any preliminary lacquer undercoating). Where a special color effect or a color characteristic of another metal is desired, color is added to the lacquer overcoating. Sometimes the appropriate dye is incorporated in the lacquer itself, but non-uniform color may be obtained if recesses in the surface of the part result in a coating of non-uniform thicknesses. More often, the lacquered surface is dipped in an aqueous dye solution for 2 to 10 sec., depending on the strength of the solution and the intensity of color desired.

Pre-metallized film and sheet are available and are being more and more widely used. Polystyrene, cellulose acetate, cellulose acetate butyrate and Mylar are currently marketed in continuous rolls of metallized film and sheet in thicknesses ranging from ½ to 40 mils. The metal films are ordinarily silver or aluminum and are applied by vacuum metallizing. Metallized plastic film and sheet can be supplied embossed with various designs, laminated to other films such as vinyl, or attached to a pressure-sensitive backing. Much pre-metallized sheet is being vacuum-formed.

Metallizing problems

Metals do not readily adhere to plastics. Inlaid strips are mechanically locked into the plastic surface. But, except for extremely thin films where intermolecular attraction is apparently sufficient, good adhesion of a metal film seems to require some kind of interlayer that has good adhesion to both the plastic and the metal. Such an interlayer is commonly provided for both chemically-reduced and electroplated coatings.

Once achieved, however, a metal film bond is still subject to the considerable shearing force that arises from the great difference in thermal expansion characteristics between most metals and most plastics. Some plastics expand and contract five to ten times as much as the metals commonly applied as films.

Compensating for such conditions requires careful planning, as well as careful control over manufacturing processes. In addition to protective lacquer overcoatings, much can be done to improve adhesion in the course of both product design and surface preparation.

Product design — The chances for good adhesion can be improved both in the design of the part and in the selection of film thickness.

The part should be designed to provide as many mechanical interlocks as possible. Indentations, grooves and reentrant curves are particularly helpful. Blistering, which may occur at positions of local bond failure, can be minimized by incorporating rounded projections on the surface. Since the practical effect of different thermal expansion rates depends on the area of contact in a given plane, large flat areas should be avoided. It is also difficult to obtain adherent metal coatings on sharp corners and edges.

Generally, an extremely thin film or a relatively thick film is preferable to a film of intermediate thickness. Thin metal films (less than one mil thick), such as those applied by vacuum metallizing, are porous and tend to expand and contract with the plastic surface. A somewhat thicker and relatively continuous film that cannot expand and contract with the plastic may fracture as a result of the differential force established. A still thicker film (say three of four mils) may have enough strength and rigidity to withstand the differential force.

Careful mold design is also important, particularly since it can often eliminate the need for special surface preparation. The need for mold release agents should be avoided, since even the smallest amount of residual mold release agent is likely to prevent satisfactory adhesion. The necessity for roughening the plastic surface (see "Surface preparation") may be avoided by incorporating in the mold a matte finish for the critical areas of the part.

Surface preparation—Prior to metallizing, the plastic surface must be thoroughly clean. Sometimes, especially for thin films, the surface must be sized. Except in vacuum metallizing, slight roughening of glossy surfaces is also recommended.

Cleaning, where necessary, is often done by solvent degreasing. Short dips in concentrated acids, acid salts, weak alkalis and other solutions have also been recommended for various materials. In all cases, subsequent water rinsing and drying is necessary. Cleaning and roughening (by etching) can sometimes be done simultaneously.

Sizing is often necessary if a continuous metal film is to be obtained on a porous material. A plastic surface is generally sized with a lacquer which, of course, must be suitable for the specific material.

Roughening of the surface provides additional opportunities for mechanical interlocking not provided in the original design. A slightly roughened surface is important for good adhesion of coatings applied by chemical reduction and electroplating, but cannot be used as a base for the exceptionally thin coatings applied by vacuum metallizing. Since a high finish is usually desirable, roughening should be kept to the minimum necessary for good adhesion.

Both mechanical and chemical methods are used for roughening. One of the simplest mechanical methods consists of rubbing the surface with a tuft of fine sand paper. Since sanding is slow and pressure is likely to be uneven, this method is generally restricted to small parts in small quantities. Higher production methods include dry sand blasting with 220-mesh aluminum oxide, wet blasting, dry tumbling with sand at about 60-70 rpm, and wet tumbling at about 30-50 rpm (a mixture of pumice, sawdust, glycerin and machine oil has been recommended). Chemical roughening treatments involve etching the surface with specific solvent solutions. The solvent solutions may be organic or may include inorganic acids, alkalies and salts. All roughening treatments are followed by water rinsing.

Application methods

Metal coatings, like paints and inks, are applied to plastics in several different ways. The method depends to some extent on the material, the size and shape of the material, the production quantities and rates required, and the equipment or suppliers available. To a far greater extent, however, the method depends upon the purpose of the coating and the service conditions to which it will be subjected.

Vacuum evaporating — Metal films intended primarily for decorative purposes are usually applied by evaporating the metal in a vacuum and condensing it on the plastic surface.

Parts to be vacuum metallized are first lacquered if necessary, then suspended in a vacuum chamber and subjected to a vacuum of 0.5 microns (0.0005 mm Hg) or lower. A tungsten or molybdenum filament, in contact with the metal to be applied, is heated to incandescence to melt and finally vaporize the metal. The metal evaporates or "flashes" in 5 to 15 sec and condenses on all cool surfaces that lie on a straight-line path from the filament.

Parts to be metallized on one side remain stationary during evaporation. Where complete coverage is desired, the parts are mounted on rotating spiders so that all surfaces are exposed to the straight-line path of the metal atoms. Vacuum metallizing of deep grooves, undercuts and interior surfaces is not practical.

Metal deposition rates are slow compared to those obtainable in electroplating, and vacuum metallizing is economically restricted to the production of extremely thin metal films. Usual film thickness is 0.003 to 0.005 mils. For such coatings on large numbers of small- or intermediate-size parts, vacuum metallizing costs about one-half as much as chemical reduction and perhaps one-fourth or one-fifth as much as electroplating where polishing and buffing are required.

In addition to low cost, vacuum metallizing offers two distinct advantages over other metallizing methods: 1) No other method is as suitable where such thin films are desired as, for example, on flexible materials. 2) Many metals and semi-metallic elements that can be satisfactorily deposited on plastics by vacuum metallizing cannot be deposited by chemical reduction or electroplating.

Highly reflective metal films can be produced by vacuum metallizing. Since the thin film tends to reproduce exactly the surface on which it is deposited, and subsequent polishing is impractical, satisfactory brilliance requires a perfectly smooth base. This base is often provided by a preliminary lacquer undercoating which is force-dried; complete solvent removal is necessary not only for maximum adhesion and hardness, but also to minimize "outgassing" under vacuum. In addition to providing a smooth, glossy surface, the lacquer undercoat seals the surface of the plastic part thereby preventing outgassing of plasticizers that might otherwise occur under vacuum.

Since a vacuum-metallized coating applied on a smooth surface is mirror-like in appearance, no chemical or mechanical brightening is necessary and some parts may receive no further treatment. However, the thin metal film has no inherent durability and is usually protected by a lacquer or enamel overcoating; the durability of a vacuum-metallized film depends almost entirely on the durability of the overcoating. Baking finishes with unusually high abrasion resistance have been developed to meet this need.

Aluminum is by far the most commonly used metal. Whereas aluminum can be vaporized by merely suspending aluminum staples over the tungsten filaments, metals which do not wet tungsten must be vaporized from molybdenum "boats" in contact with the filaments. Since the metal atoms travel in a straight line, parts to be coated with metals other than aluminum cannot be placed all around the filaments but must be placed or rotated into position above the boats.

For decorative purposes, little advantage is gained by using a metal other than aluminum. As deposited by vacuum metallizing, aluminum has the appearance of polished white metals such as platinum, silver, rhodium or chromium and, even without further protection, it does not tarnish. Other metals can be simulated by appropriately coloring the protective lacquer overcoating.

However, metals such as copper, gold, silver, selenium and cadmium are sometimes applied for functional purposes. Many other useful metals can also be evaporated, though most with considerably more difficulty.

Because of the exceptionally thin films deposited, the materials cost of vacuum metallizing is quite low. Initial equipment cost, however, is high. A complete setup utilizing a standard-size chamber (a horizontal cylinder 60 in. long and 48 in. in diameter) costs approximately $35,000 to $40,000, including pumping system, lacquering facilities, lacquer-drying ovens, trucks, racks, jigs, etc. An installation of this size can handle up to 10,000 small parts per hour.

A major cost consideration is the labor required to rack the parts for the metallizing and lacquering operations. This cost can be minimized to a certain extent in the design stage. First, metallizing can be confined to one surface so that the part need not be turned or rotated during metallizing or lacquering. Second, the mold for small parts can be designed so that a number of small parts remain attached to the gating until after finishing, thus minimizing the number of parts to be handled.

Perhaps the most critical part of the vacuum metallizing operation is the lacquering. It takes something of an expert to get good results with a hand spray gun. Automatic spraying machines are reliable but expensive. A method less expensive than automatic spraying and less critical than hand spraying is dipping, followed by spinning off the excess, then slowly rotating the parts to assure uniform coverage.

Normal precleaning for vacuum metallizing consists of degreasing, rinsing and drying. Sometimes a high-voltage clean-up may be used where especially good adhesion is required. The parts are subjected to a high-voltage (about 2500 v., 200 milliamps) discharge which ionizes the residual gas in the vacuum chamber and bombards the surfaces, thus releasing the last traces of moisture and absorbed gases from the surfaces.

Cathode sputtering — Another vacuum metallizing process known as "cathode sputtering" is sometimes used for plastics. It utilizes a relatively low vacuum (1 to 0.01 mm Hg) together with high-voltage electric current (up to 10,000 v. or more). The metal to be deposited is made a cathode, and the plastic part is placed on or near another metal surface which is made an anode. Metal ions leave the cathode and are deposited on the plastic surface.

Chief advantage of cathode sputtering compared to vacuum evaporating is lower initial cost of equipment. Because of the lower vacuum, less expensive pumping equipment is needed and no separate degassing chamber is required. Chief disadvantage of cathode sputtering is a much lower evaporation rate and, consequently, lower production capacity. Also, some metals, including aluminum, that can be deposited by vacuum evaporating cannot be satisfactorily deposited by cathode sputtering.

Phenolic *flashlight reflector vacuum metallized with aluminum.*
(National Carbon Co.; Auburn Button Works)

Chemical reduction — Mirror-like metal films, relatively thin but considerably thicker than those obtained by vacuum metallizing, can be produced on plastics by precipitating the metal from a chemical solution. Chemically reduced coatings are used primarily for silver mirrors and reflectors and as a base for electroplated coatings.

Chemical reduction coating is a multi-step method and not a simple one. Most processes require careful control of concentrations, temperatures and times. The coating itself is usually preceded by cleaning, sizing, roughening and chemical sensitization of the plastic surface. Where plating is not to follow, a chemical reduction coating is often protected by a lacquer overcoating.

Sensitizing of the plastic surface not only appears to be necessary for good adhesion, but also reduces the time needed to form the metal film and provides a more uniform film. Just how sensitization occurs is not fully known. A plastic surface is usually sensitized by exposing it to a solution of tin chloride in water or alcohol. Immersion time required may vary from a few seconds to as much as 30 min, depending on the solution and the material. The sensitizing agent is removed by water rinsing.

Although silver is most common, copper, nickel and gold films can also be applied to plastics by chemical reduction. For each metal, a great many different solutions have been developed.

Silver is almost invariably deposited from an ammoniacal solution of silver nitrate. Perhaps the best reducing agent is ordinary cane sugar ("Brashear process") which operates at room temperature. It produces hard, brilliant films and is particularly suitable for applying a second film over the first. Rochelle salts (sodium-potassium-tartrate) provides films only slightly less brilliant and also operates at room temperature. About equally effective is tartaric acid which, however, requires a slightly elevated temperature. Formaldehyde and hydrazine solutions are also effective and widely used. Silvering solutions may be applied by dipping, wiping and, most economically, by spraying. Only rapid-film-forming solutions are suitable for spraying. Like most silver nitrate solutions, silvering solutions must be handled with care to avoid dangerous explosions.

Theoretically, copper has many advantages over silver where electrical conductivity, not reflectance, is the principal object. Depositions rates are slower, however, and chemical reduction coatings of copper are not widely used. Common reducing agents for copper include the tartrates, formaldehyde, sugars and hydrazines.

Nickel films are generally reduced from a hot (about 200 F), alkaline, nickel chloride solution by means of sodium hypophosphite ("electroless nickel plating"). A number of widely used commercial processes have been developed in the past two years. The elevated temperature required limits most plastics applications to thermosets.

Gold films have limited applications because gold salts are expensive and because the color of gold can easily be imitated by other techniques. Gold films can be precipitated from an aqueous gold chloride solution by adding first an alkali, then a reducing agent. Suitable reducing agents include alcohol, sugar, glucose, citric acid and formaldehyde.

Electroplating—Relatively thick metal films (2-3 mils or more) are applied to plastics by electroplating. Electroplated films are much more durable, but also more expensive, than metal films applied by other methods. Ordinarily, electroplating is selected in preference to other metallizing methods only where 1) a heavy plate is desired for durability or electrical conductivity, or 2) the parts are small enough for barrel plating, which is much more economical than still-tank plating.

A plastic surface to be electroplated must be provided with an electrically conductive coating—usually an electrically conductive paint or a chemical reduction coating of silver or copper. Next, an intermediate layer of copper, silver or nickel is plated, then polished by buffing, tumbling or bright-dipping. Finally, the top plate is applied.

Plating itself is similar to plating on metals, but with certain limitations:

1. Some plastics, notably polystyrene, are less dense than normal plating solutions and therefore tend to float. Such parts must be either held in special fixtures or weighted with a preliminary plate in a low-specific-gravity solution before being transferred to a normal solution.
2. A hot plating bath must be avoided, since it would soften or distort most plastics.
3. Because the electrically conductive coating is quite thin, a high current density cannot be used initially unless a number of current-distributing contacts are made with the conductive coating.
4. Since the conductive coating is generally porous, highly acid or highly alkaline plating baths are unsuitable for plastics having relatively low resistance to such environments.
5. Since an acid solution, unless carefully controlled at the beginning, tends to strip off chemical reduction coatings, the intermediate plate must sometimes be deposited in two steps: 1 to 5 min in a preliminary alkaline bath, followed by an acid bath.
6. Reverse polarity must be avoided since it tends to strip the film along with the oxide. It is preferable to avoid oxide formation by plating as rapidly as possible.

Barrel plating eliminates individual polishing and much handling labor. Ordinarily, parts to be barrel-plated are also cleaned, roughened and provided with a chemical reduction coating in rotating barrels. Most of the limitations on still-tank plating of plastics apply also to barrel plating. In addition, it is difficult to obtain good plates on parts having sharp edges and corners, since the chemical reduction coating tends to be rubbed off such areas. Similar difficulties are encountered even on relatively flat areas of some of the heavier plastics, such as ureas, since the parts rub against each other with considerable force.

Any metal that can be commercially electrodeposited on a metal surface can be electrodeposited on a suitably prepared plastic surface. However, electroplates on plastics generally cost more than electroplates on metal because of 1) the need to produce a conductive surface, 2) the special handling necessary for low-density materials, and 3) the greater plate thickness needed to withstand the forces resulting from differential thermal expansion of plastic and metal.

Spraying—Metal coatings can be applied to plastics by blowing molten metal onto the surface with compressed arc. The molten metal may be obtained by feeding metal wire or powder to a flame, or by melting the metal in a pot and drawing it through the spray gun nozzle. In any case, sprayed metal coatings are brittle and granular as applied and are therefore seldom used on plastics.

Metal inlaying—An expensive but unusually durable metal finish can be achieved by inlaying a strip of metal in the plastic surface. The recess required may be molded-in or engraved.

Several methods of inlaying have been patented. Usually, a thin strip of metal that is only half the thickness of the recess is placed in the bottom of the recess. A slightly convex and oversize strip of the inlay metal is placed on top of the base strip and pressed down. Since the base metal strip is harder than the plastic, the edges of the inlay are forced into the plastic and the inlay is locked in place. Another method is to mold the recess with excess material around it; after the inlay has been inserted, the excess material is softened and forced over the edges of the inlay.

A number of striking decorative effects can be achieved with metal inlays but, since they are more expensive than other types of metallic finishes, they are generally used only where great durability is required, as in outdoor applications. Inlays of metals subject to tarnishing may be protected by a lacquer overcoating.

A technique somewhat similar to metal inlaying involves the use of metallized Mylar film. The film is cut to size and inserted in or laminated to the plastic surface with the metal coating on the inside, protected by a tough, transparent film.

Selecting a Finish

So far, this article has attempted to describe the materials and processes that are used to achieve functional or decorative finishes on plastics. This concluding section will outline briefly the types of finishes that are most common and the types of applications for which they are most suitable.

Functional finishes

The most important functional contributions made by finishes for plastics are listed below. Many finishes, including some applied primarily for decorative purposes, may perform two or more of these functions.

An *electrically conductive* surface can be provided by a silver-pigmented paint or metal coating. Conductive paints are used in printed circuits or as a base for electroplating. Chemical reduction coatings of silver or copper are used primarily as a base for electroplating. Vacuum-metallized Mylar film is used in condensers and capacitors. Typical applications for electroplated metal coatings are slip rings, commutators, high-frequency wave guides, shielded housings, airplane antenna masts, condensers and contacts for electrical leads.

A *light-reflecting* surface can be provided by a white or aluminum-pigmented paint or a white metal coating. Highest-quality mirrors and reflectors, such as those used in optical parts, are made with silver reduction coatings. Less expensive but highly-reflective coatings, such as those for flashlight reflectors and spotlights, can be provided by vacuum-metallized aluminum films. Both types of coatings are ordinarily protected by clear lacquers—on silver reduction films to prevent tarnishing and on vacuum-metallized films for greater durability.

A more *abrasion-resistant* product can sometimes be achieved by applying a paint or metal finish either to the entire surface or to specific areas subjected to the greatest wear. Paints are usually applied by dipping, brushing or spraying, and metals are usually applied by electroplating. A good example of the use of paints is the neoprene coating on leading edges of reinforced-plastics aircraft components to reduce rain erosion. Typical applications in which metal coatings are important for durability as well as decorative effect are hardware, instrument control knobs and luggage accessories.

A more *water-resistant* surface can often be provided by a coating that is thick enough to be relatively non-porous. An example is the use of a clear or pigmented lacquer or enamel on glass-reinforced plastic boats to prevent excessive water absorption through the wicking action of the glass fibers.

A more *chemically resistant* molding can sometimes be achieved by coating it with a transparent lacquer. Such a coating is usually applied by spraying or dipping. Typical applications are polystyrene and cellulose acetate housewares and novelties that may be subjected to oils, gasoline, foods, beverages, cleaning fluids, fingerprints, etc.

A *lower-cost* product can sometimes be achieved by molding it of scrap plastic that would otherwise be rejected because of streaks or uneven coloring, then applying an over-all surface finish having sufficient hiding power to produce a uniform appearance. Such finishes may consist of a lacquer applied by spraying or dipping or a vacuum metallized film protected by a clear lacquer. Typical of such vacuum metallizing applications are children's musical instruments and military toys.

A more *heat-resistant* product can sometimes be achieved by providing an electroplated metal coating on part or all of the surface so that localized heat can be more readily dissipated.

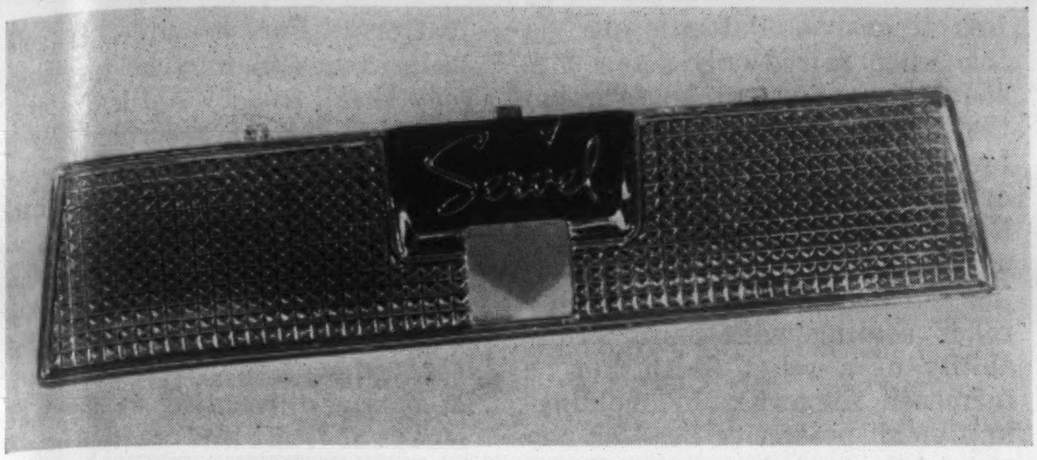
A *stronger* or *more rigid* product can sometimes be achieved by providing it with a relatively thick electroplated coating.

A *solderable* surface can be provided by a chemical reduction or electroplated metal coating. Typical applications are printed circuits and small electrical housings to be joined to metal end caps.

An *anti-static* surface can be achieved by coating it with a

Polyester film, *vacuum metallized with aluminum, then laminated to vinyl film and embossed, is used as interior trim on the 1955 Dodge.*

(Dorrie Processing Co.; E. I. DuPont de Nemours & Co., Inc.)



***Second surface finishes** are used on this nameplate molded in clear amber polystyrene. The black background is applied by hot stamping, and a metallic gold effect is obtained in the letters and in the "diamond" area by vacuum metallizing with aluminum. A gray enamel is sprayed on to protect the metallized coating.*

(General American Transportation Corp.)

transparent film consisting essentially of a surface-active agent, such as a sulfonate, or a humectant, such as glycol or glycerine. Such a film is usually applied by dipping or wiping, and its solvents generally exert some cleaning action. Anti-static agents vary widely in their effectiveness and their durability; the most effective film is often not the most durable. Typical applications are polystyrene, cellulosic and vinyl housewares where minimum dust attraction is desirable. Any "electrically conductive" finish also serves as an effective anti-static finish.

Decorative finishes

For convenience, the various types of decorative finishes will be classified here according to their location with respect to the principal surface of the plastic molding or sheet.

A *surface* finish is one applied to the principal surface of the plastic. Paints applied by spraying or dipping are used where one or two colors are to be applied rather broadly, as on panels, signs or parts requiring a hiding finish. If a metallic color is desired, the part may be vacuum metallized with aluminum, then coated with a transparent lacquer of the desired color. Pre-metallized transparent sheet and film are available with or without a colored top lacquer, and with or without various embossed designs. A similar, but more durable, finish can be obtained by electroplating or metal inlaying instead of vacuum metallizing.

Marks or decorative patterns of varying complexity and of one, two or many colors can be applied to moldings by silk screening, offset printing, decals or mask-spraying; to sheet by silk screening, offset printing or letterpress printing; and to continuous film by gravure or flexographic printing. Typical applications are display signs, illuminated masks, housewares and packaging materials. A metallic background for such a finish can be provided by applying it over a vacuum-metallized and lacquered surface. Sheet that is to be formed may be pre-decorated in such a way that the colors are in proper registration after forming.

The appearance of solid or plated metal can be simulated by vacuum metallizing, by chemical-reduction coating or, on small parts or where a more durable finish is required, by electroplating. A chromium finish can be simulated by vacuum metallizing with aluminum and protecting the thin film with a clear lacquer. An electroplated chromium finish on a plastic ordinarily needs no further protection, but other electroplated coatings such as silver, copper or gold may require a protective lacquer to avoid tarnishing. Typical metallized plastic products are buttons, toys, costume jewelry, cigarette cases, compacts, mirror and brush handles, bottle caps, drawer-pulls, lamp bases, automotive trim, nameplates and novelties.

Special surface effects such as frost, luminescence or pearl can be obtained with special paints. They are commonly used on toys, novelties and jewelry. The appearance of various fabrics in many different colors can be simulated by flocking. Flock finishes are used primarily for interiors of containers, such as jewelry and gift boxes, drawers and instrument cases.

A *depressed* or *flush* finish is applied to a recessed area of the plastic. Recessed marks or patterns may be molded-in, engraved by hand or by pantograph from a master pattern, or hot stamped. Such designs need be only a few mils deep to be visible, but greater visibility can be achieved through contrasting colors. Contrast can be obtained by coating the principal surface, the recessed surface, or both in different colors.

Recessed marks, letters, numerals and line drawings may be colored by hot stamping or by filling with paint (a "wipe-in" coating).

Ordinarily, recessed designs are imprinted and colored simultaneously by hot stamping with inks or roll leaf. Two or more colors can be applied in a single operation. Hot stamping is not too satisfactory for thermosetting plastics. However, color can be applied from roll leaf to already-recessed surfaces by means of a hot matching die. Typical hot stamping applications are radio and TV tuning dials, instrument dials, nameplates, bottle caps, toothbrush handles and consumer packages.

For thermosetting plastics, large parts or small quantities, a wipe-in coating is generally used instead of hot stamping. A wipe-in coating may be applied by brushing, flowing or spraying a high-viscosity paint into already-prepared grooves. Lacquer sticks are also available. In spraying, masks are used to confine the paint to the immediate area. The paint is allowed to dry for a period ranging from 10 to 60 min., depending on the nature of the formulation. The excess paint is then removed from the adjacent area by wiping with a dry or thinner-soaked cloth, buffing or tumbling. Depth of grooves to be filled with paint usually ranges from 0.005 to 0.015 in. Maximum groove width of 1/32 in. is recommended to avoid disturbing the applied finish during wiping. Paints applied to recessed areas need not be so durable as those applied on principal surfaces.

Relatively broad recessed grooves or areas may be vacuum metallized, and metal inlaying may be used for broad panels where good durability is required. Broad areas of color are sometimes applied by roll leaf stamping, particularly where the background and not the pattern itself is to be colored. Since the durability of a roll leaf finish depends considerably on its location below the principal surface, such finishes applied to broad areas are not very durable.

A *relief* finish is applied to a raised area of the plastic. A relief area may be molded-in or engraved; a molded design is usually less expensive. Patterns are visible when raised only a few mils above the principal surface but the contrast may be heightened by painting either the background or the design a different color. Relief patterns of one plane are usually colored by roll leaf coating (utilizing a hot pad) or by roller coating with paint. Durability of a relief finish can be increased somewhat by molding in a small protective bead or rim around the coated area. A pattern of more than one plane can be painted by mask-spraying or brushing.

Flock Finishes

Finishes of many different colors and ranging in appearance from rich, velvet-like to dull, suede leather-like can be produced for a few cents a square foot by flocking.

An adhesive paint is applied to the surface to be coated; when it becomes tacky, it is sprinkled with fiber sections, metal powders or special "frosting" powders. The flocking material adheres to the coated surfaces and is firmly attached when the paint dries. Rayon is the most extensively used flocking material. Other widely used flocks are cotton, wool and animal hair.

Adhesive paints for flocking must not be too quick-drying, they should not produce glossy films, and they should be of the same or a slightly darker color than the flock. The paints can be applied by any of the methods commonly used for paint and ink finishes; for complex patterns, silk screening is preferred to printing because it provides a thicker adhesive film.

Flocks are usually applied to moldings by spraying. Continuous sheet may be coated by a "beater bar" method in which the sheet is caused to vibrate while the flock is sifted onto the surface. Another, more expensive method utilizes an electrostatic field. The negatively charged fibers, drawn toward a positive electrode, seat themselves vertically and evenly spaced in the adhesive.

A *second-surface* finish is applied to the back side of a transparent plastic and may involve a surface finish, a depressed finish or both. Attractive finishes having a three-dimensional effect can be achieved; they are usually applied to polystyrene or acrylics. Parts should be molded in highly-polished molds, since defects are readily visible on a finished second surface.

A simple surface finish can be produced by applying either an opaque paint or a vacuum-metallized aluminum coating to the back surface. If a metallic color other than the characteristic aluminum color is desired, a clear lacquer is applied and dyed prior to metallizing. A paint applied to a back surface need not have a high gloss, since the transparent plastic adds gloss to its appearance.

A simple depressed finish can be produced by applying a wipe-in or vacuum-metallized coating to a pattern that has been molded-in or engraved on the back surface, or by hot stamping. Metallic panel effects can be achieved by vacuum metallizing or, if greater durability is required, by metal inlaying. Metal inlaying itself offers several possibilities; the inlay may carry an etched or lithographed design, or the base strip may be a stencil that allows the top strip to show through in a definite pattern. Such designs may also be inlaid in duplicate so that they can be seen from both sides. If a color other than that characteristic of the metal is desired, a clear, colored lacquer is applied first.

Many second-surface finishes are applied both to the principal back surface and to a depressed pattern. For example, a gold-colored design may be imprinted on a small part by roll leaf stamping, lacquers of several different colors applied to the back surface in a regular pattern, the back surface metallized so that those portions finished with clear colors have a metallic appearance, and the entire back surface then sprayed with a protective paint. If a wipe-in coating is used instead of roll leaf stamping, it must be compatible with any paints applied directly over it. Another way to decorate the principal back surface and simultaneously protect a depressed finish is to bond a colored, opaque plastic panel to the back surface.

In a *combination* finish, part of the total pattern appears on the first surface and part is seen through the transparent plastic. Unusual three-dimensional effects can be achieved. For example, by printing or metallizing similar designs slightly offset from one another on both the first and second surfaces, it is possible to create the effect of a three-dimensional pattern that extends through the material from one surface to the other. Second-surface and combination finishes are widely used on auto horn buttons and emblems, instrument dials, and nameplates for home appliances.

Acknowledgment

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MATERIALS ENGINEERING FILE FACTS

MATERIALS & METHODS • JUNE 1955 • NUMBER 300

Acrylic Plastics — MATERIALS DATA SHEET

These thermoplastic materials are characterized by transparency, an excellent combination of flexibility and shatter-resistance and the best resistance of all transparent plastics to sunlight and outdoor weathering. They are particularly suited to applications involving light transmission. Because stresses reduce their resistance to weathering, they are not usually recommended for structural parts, although a reasonable service life can be expected under stresses not exceeding 1000 psi at temperatures below 140 F.

TYPE	ASTM Test Conditions	Cast Resin Sheets, Rods, etc.		Molding Powder		
		General Purpose Type I^a	Heat Resistant Type II^a	Grade 5^b	Grade 6^b	Grade 8^b
PHYSICAL PROPERTIES						
Specific Gravity	D792	1.18–1.19	1.18–1.19	1.18–1.19	1.18–1.19	1.18–1.19
Thermal Cond, Btu/hr/sq ft/ft/°F	Cenco-Finch	0.10–0.15	0.10–0.15	0.10–0.15	0.10–0.15	0.10–0.15
Coeff of Exp per °F	D696	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}
Spec Ht, Btu/lb/°F	—	0.35	0.35	0.35	0.35	0.35
Refractive Index	D542	1.485–1.500	1.485–1.495	1.49	1.49	1.49
Transmittance (Luminous)	D791	91–92	91–92	91–92	91–92	91–92
Haze	D672	1–2	1–2	<3	<3	<3
Water Absorption, 24 hr %	D570	0.3–0.4	0.2–0.4	0.4	0.4	0.3
Flammability in./min (over 0.050 in.)	D635	0.5–2.5	0.5–2.5	1.0	1.0	1.0
MECHANICAL PROPERTIES						
Mod of Elast in Ten, psi	D638	$3.5–4.5 \times 10^5$	$4.0–5.0 \times 10^5$	4.5×10^5	4.5×10^5	4.5×10^5
Ten Str, psi	D638	6000–8000	8000–10,000	7500–8500	7500–9000	8000–10,000
Elong in 2 in., %	D638	2–7	2–7	2–10	2–10	2–10
Hardness, Rockwell	D785	M88–M92	M96–M102	M84–M87	M92–M95	M102–M105
Impact Str, Izod Notched (ft-lb per in. of notch)	D256	0.5	0.4	0.4	0.5	0.5
Mod Elast in Flex, psi	D790	$3.5–4.5 \times 10^5$	$4.0–5.0 \times 10^5$	4.5×10^5	4.5×10^5	4.5×10^5
Flex Str, psi	D790	12,000–14,000	15,000–17,000	13,000–15,000	14,000–16,000	15,000–17,000
Compressive Yld Str 0.1% offset, psi	D695	10,000–12,000	12,000–14,000	12,000–13,000	13,000–14,000	14,000–17,000
ELECTRICAL PROPERTIES						
Elect Res, ohm-cm	D257	$> 10^{15}$	$> 10^{15}$	$> 10^{14}$	$> 10^{14}$	$> 10^{14}$
Dielectric Str (Short Time) volts/mil	D149	450–500	450–500	450–500	450–500	450–500
Dielectric Constant:						
60 cycles	D150	3.5–4.5	3.5–4.5	3.5–4.5	3.5–4.5	3.5–4.5
1,000,000 cycles	D150	2.7–3.2	2.7–3.2	2.7–3.2	2.7–3.2	2.7–3.2
Loss Factor						
60 cycles	D150	0.17–0.27	0.17–0.27	0.14–0.23	0.14–0.23	0.14–0.23
1,000,000 cycles	D150	0.50–0.10	0.05–0.10	0.05–0.10	0.05–0.10	0.05–0.10
FABRICATING PROPERTIES						
Injection Molding Pressure, psi	—	—	—	15,000–25,000	15,000–25,000	20,000–30,000
Injection Molding Temp, F	—	—	—	350–425	375–450	400–475
Compression Ratio (Bulk Factor)	—	—	—	1.6–2.2	1.6–2.2	1.6–2.2
Hot Forming Temp, F	—	250–320	280–340	—	—	—
Extruding Temp F	—	—	—	350–400	375–425	400–450
MAXIMUM RECOMMENDED SERVICE TEMP, F	—	140–160	180–200	155	165	185
CORROSION RESISTANCE	—	Resistant to weak alkalies, acids and aliphatic hydrocarbons; attacked by esters, ketones, aromatic hydrocarbons, chlorinated hydrocarbons, concentrated acids				
USES	—	Transparent aircraft enclosures, radio and television parts, lighting, drafting equipment, signs		Decorative and functional automotive parts, reflectors, protective goggle lenses, radio and television parts, household appliance parts		

[a] Correspond to ASTM D702-46

[b] Correspond to ASTM D788-48T

Prepared with the assistance of the Manufacturing Chemists' Association, Inc., based on the Chemists' Association Publication, "Technical Data on Plastics", 1952.

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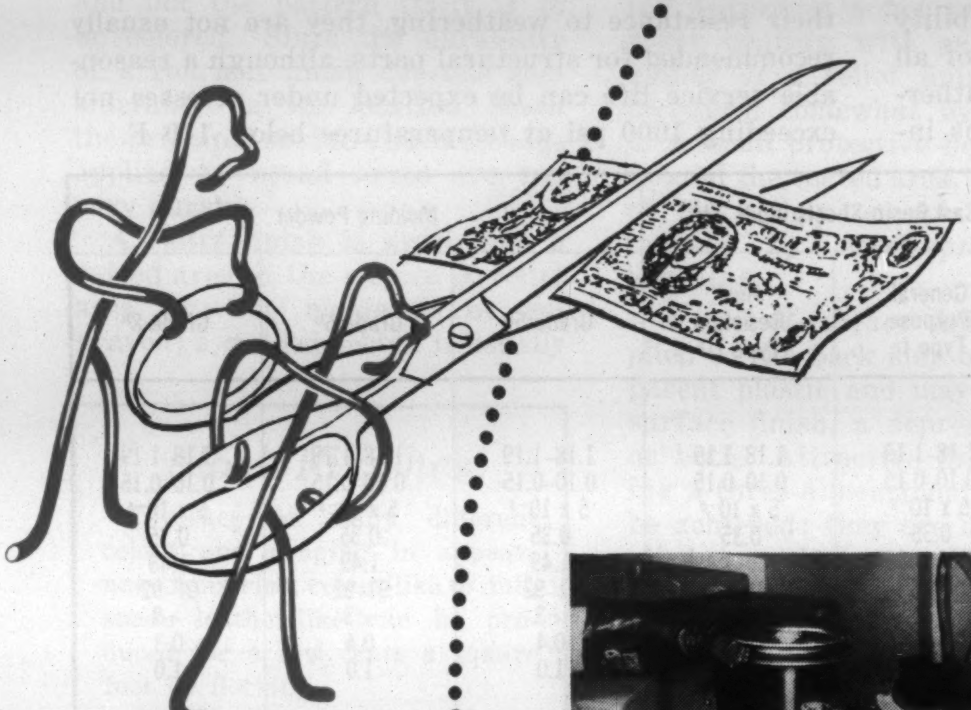

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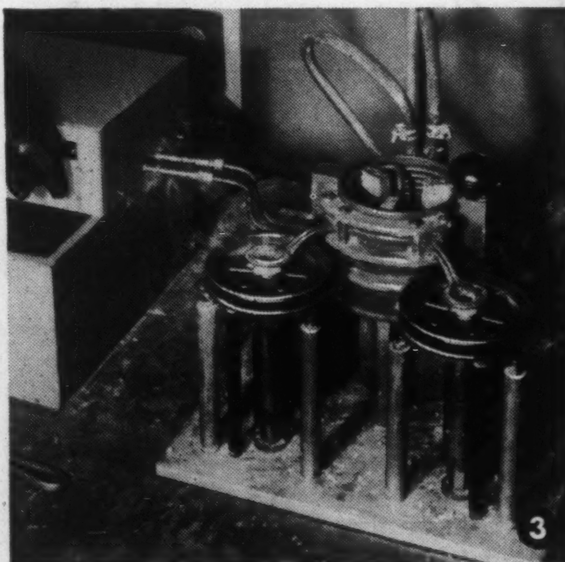

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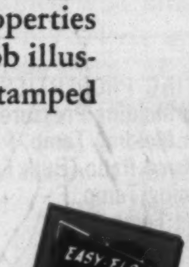

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MATERIALS ENGINEERING FILE FACTS

MATERIALS & METHODS • JUNE 1955 • NUMBER 301

How Some Elements Affect Steel

About twenty different elements, ranging from aluminum to zirconium, are used today in various combinations and proportions in the manufacture of carbon and alloy steels. Some are used to rid the steel of harmful impurities, others as scavengers to counteract the effect of oxides or gases.

However, some are used because of the specific properties which they impart to the steel when they alloy with it or when they combine with the carbon to form carbides. The relative effects of various elements in this last group on steel properties are indicated in the following table.

Representative Types of Steel (Carbon approximately 0.40%)	Index of Physical Properties (Compared with straight carbon steel)				Distinguishing Characteristics	Typical Uses
	Breaking Strength	Relative Elasticity	Ductility	Hardness		
Straight Carbon (C 0.40%)	100	100	100	100	—	Railroad track bolts, automobile axles and brake levers
Medium Manganese (Mn 1.75%)	145	155	58	138	Good strength and workability	Logging and road and agricultural machinery
Straight Chromium (Cr 0.95%)	157	177	63	147	—	Springs, shear blades, wood cutting tools
3½% Nickel (C 0.30, Ni 3.5%)	202	224	63	192	Toughness	Rock drill and air hammer parts, crankshafts
Carbon-Vanadium (C 0.50, V 0.18%)	158	179	68	153	Resists impact	Locomotive parts
Carbon-Molybdenum (C 0.20, Mo 0.68%)	149	162	53	164	Resists heat	Boiler shells, high pressure steam equipment
High Silicon Sheets (Si 4.00%)	Electrical Properties of Prime Importance				High electrical efficiency	Transformers, motors, generators
Silicon-Manganese (Si 2.00, Mn 0.75%)	198	224	42	180	Springiness	Automobile and railroad car springs
Chromium-Nickel (Cr 0.60, Ni 1.25%)	115	125	94	120	Surface easily hardened	Automobile ring gears, pinions, piston pins, transmissions
Chromium-Vanadium (Cr 0.95, V 0.18%)	202	229	52	225	High strength and hardness	Automobile gears, propeller shafts, connecting rods
Chromium-Molybdenum (Cr 0.95, Mo 0.20%)	130	135	94	125	Resists impact, fatigue and heat	Aircraft forgings and fuselages
Nickel-Molybdenum (Ni 1.75, Mo 0.35%)	155	177	68	153	Resists fatigue	Railroad roller bearings, automobile transmission gears
Manganese-Molybdenum (Mn 1.30, Mo 0.30%)	158	177	68	151	Resists impact and fatigue	Dredge buckets, rock crushers, turbine parts
Nickel-Chromium-Molybdenum (Ni 1.75, Cr 0.65, Mo 0.35%)	158	203	63	161	Resists twisting	Diesel engine crankshafts
High Speed Steel (Tungsten 18, Cr 4, V 1.0%)	Cutting Properties of Prime Importance				Stays hard at high temperatures	High speed metal cutting tools
Cobalt Magnet Steels (Co 35.0%)	Magnetic Properties of Prime Importance				High magnetic strength	Permanent magnets in electrical apparatus
18:8 Stainless (Cr 18, Ni 8%) (Cold Worked)	207	219	53	165	Resists corrosion	Surgical instruments, food machinery, kitchenware

Courtesy of American Iron and Steel Institute

The tough jobs are easy

Photo and data courtesy of The International Nickel Co., Inc.

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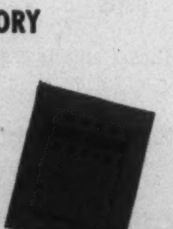

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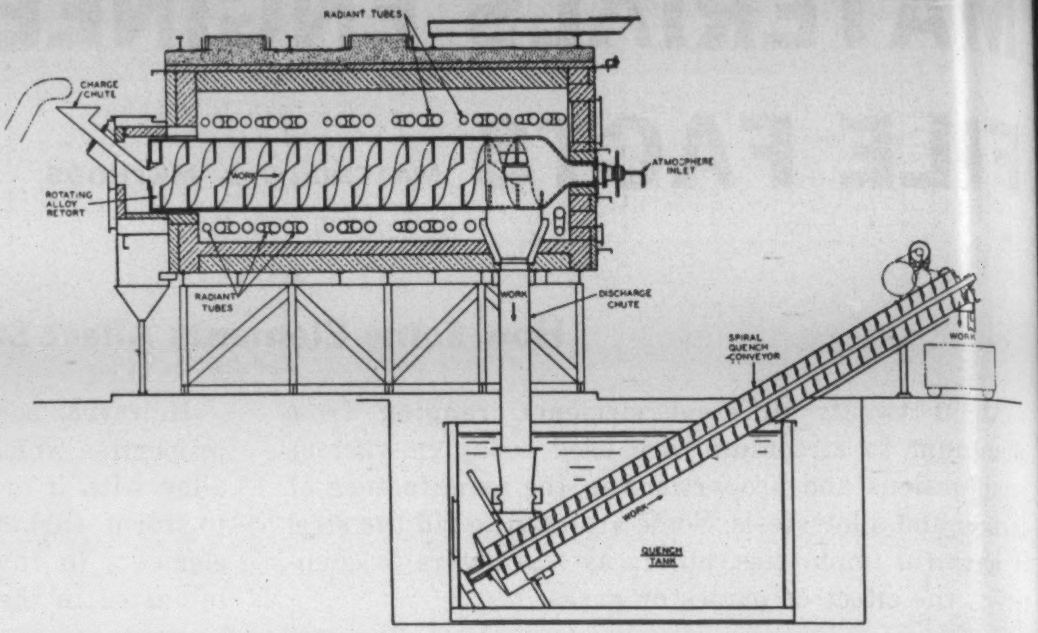

Rotating retort furnace *with radiant tubes and enclosed quench tank. Note perforated spiral conveyor that carries work out of the quench tank to floor level.*

(Photos courtesy of Surface Combustion Corp.)

Change to Gas-Carburizing Improves Piston Pins

by **R. E. Haislip**, *Chief Metallurgist, Chrysler Corp.*

Piston pin *section shows carburized case. Pin measures 1 in. o.d. x 47/64 in. i.d. x 3.15 in. in length.*

■ In automobiles, small parts are often subject to critical improvements. The 100% surface-hardened wrist pins used in every Chrysler Fire Power V-8 engine provide a typical example.

Before the present surface-hardening system was adopted, wrist pins were pack carburized at 1680 F to produce a total case of 0.030-0.040 in. depth after grinding. The over-all process involved three additional heat treatments—a heat at 1600 F and a reheat at 1400 F, both in cyanide bath, followed by a 400 F temper.

Pack hardening and the associated heat treatments were time consuming and costly. In addition, the finish of heat-treated parts lacked uniformity, due, primarily, to the pack-carburizing operation.

The piston pin or "wrist" pin must withstand the most rigorous service conditions. Operating temperatures are very high and lubrication is difficult. Dimensional tolerances are critical, and pins must be finish ground to within 0.0001 in. Non-uniformity of case depth, excessive carbon concentration inside and out, and resultant variations of surface hardness cannot to be tolerated in high-compression engine piston pins.

Pins now gas carburized

The surface hardening method was changed from pack carburizing to gas carburizing to reduce process time and improve quality factors. A much shorter over-all production cycle resulted, due to the elimination of two heat-treat operations, and uniformity increased markedly through each pin and from pin-to-pin.

The change to a quench directly from the carburizing furnace requires substitution of a fine grain,

PRODUCTION TEST RESULTS AISI-1117 PISTON PINS AFTER GAS CARBURIZING AND QUENCHING

Hardness RC on O.D. at Separate Points		Depth of Case, in. (Total)	
1st Point	2nd Point	O.D.	I.D.
63 RC	64 RC	0.040 in.	0.032 in.
62	63	0.040	0.034
62	64	0.036	0.030
63	65	0.038	0.034
62	64	.036 .038	.032 .030
62	63	0.040	0.034
61	63	0.040	0.034

AISI-1117 steel, for the coarse grain material previously used. The fine grain structure prevents precipitation of excessive carbide networks and results in a core of maximum strength, characteristics ideal for a piston pin. Reference to the table will show the hardness gradient achieved from outside to inside surfaces. Gas carburizing also makes possible a uniform hardness on the critical inside surface.

The production of piston pins was of such volume as to accommodate a continuous type furnace. The furnace selected incorporates a rotating retort with internal spirals that move the parts forward in tumbling motion through a heating chamber to a vertical-discharge chute. The carburized pins drop through the atmosphere-filled chute into a quench tank.

The single retort is a heat-resistant alloy casting 30 in. in dia and 124 in. in effective length. The retort rotates, tumbling the parts and exposing all surfaces to the carburizing gas atmosphere.

Pins are charged to the retort by a vertical flight type conveyor that lifts them from a floor level hopper to the charge chute. The pins drop down this inclined chute through a throat and into the retort. At the discharge end several drop out of the retort every time the discharge openings center over the quench chute. This alloy quench chute extends through the furnace bottom and into the quench tank below the level of the caustic quench solution. The quench tank contains a rotating, perforated drum, with internal spirals, to remove the quenched parts from the bath.

Atmosphere important

The "carrier" prepared gas atmosphere used in the retort and in the furnace heating chamber surrounding the retort, is produced by a Surface Combustion RX gas generator which supplies gas of the approximate composition: CO_2 — 0.0%, CO — 20.3%, CH_4 — 0.3%,

PACK CARBURIZE
Old Method

1. Pack carburize at 1680 F
2. Box cool
3. Heat in cyanide at 1600 F for 20 min
4. Quench in oil
5. Reheating in cyanide at 1400 F for 20 min
6. Quench in solution
7. Temper at 400 F for 30 min, 58 RC min

GAS CARBURIZE
New Method

1. Gas carburize at 1680 F
2. Quench in caustic solution
3. Wash
4. Temper at 400 F for 30 min, 58 RC min

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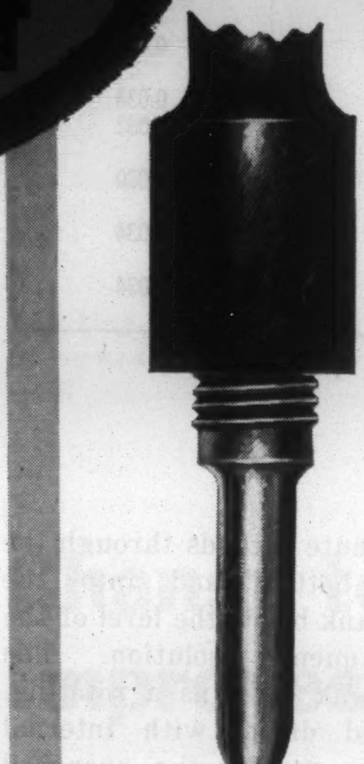
INSIDE STORY
AUSTENAL SILENT TREATMENT



This is the inside of a creep rupture machine at Austenal Laboratories. A bar of ultra-strong alloy is subjected to high stress for many hours at jet engine temperatures until it finally ruptures.

The drawing symbolizes determination of rupture strength of an alloy to be used in Austenal's Microcast process for the investment casting of high temperature components for jet engines. This is one of many laboratory tests used to ensure the quality and dependability of the alloys used.

The alloy was made in Austenal's own alloy plant. Skilled metallurgists and chemists produce alloys to pre-determined specifications and check and re-check each individual melt to ensure high quality standards.

Quality control is basic in Austenal's Microcast process. It is just one of the reasons why more jet engines use Austenal components than any other—and why American industry depends upon Austenal.

Let Austenal help solve *your* precision casting problems. Austenal Microcast can simplify and improve your entire production picture.

See Austenal's original informative 16mm color movie, "A Story of Industrial Progress". Available without charge.

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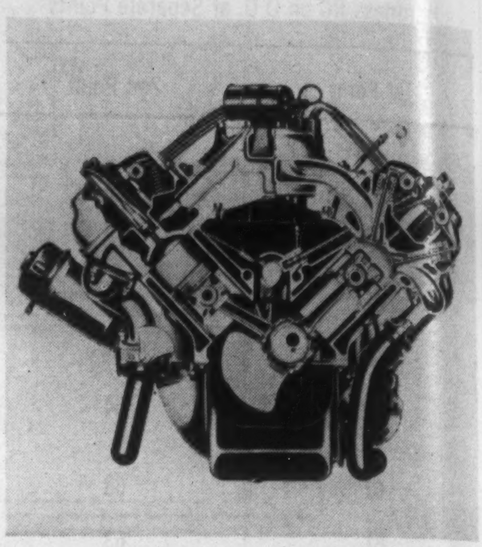
For more information, turn to Reader Service Card, Circle No. 466

PISTON PINS

Continued from page 141



Cross section *of a Fire Power V-8 engine. Note location of wrist pins in each piston of this eight-cylinder engine.*

H_2 — 39.6% and remainder N_2. Dewpoint is +21 F.

About 850 cfh of gas at a pressure of 7 in. w.c. is required for full production. An additional 55 cfh of natural gas is added to the RX generator gas as it is introduced into the retort through an inlet in the discharge end. The furnace atmosphere pressure is usually about +0.10 in. w.c. All "spent" atmosphere is burned off at the charge end at the throat of the charge chute.

The quality of the case obtained in this furnace is dependent on atmosphere control and the maintenance of ideal atomsphere conditions in the furnace.

The following conditions are essential: maintaining a tight furnace; keeping the furnace clean of carbon; and operating with atmosphere of a low dew point and low CH_4 content. The work charged into the furnace must be dry and free of moisture. Furnace atmosphere analysis and dew points are checked daily. Two production pins are also checked for hardness and case every day.

An improved production picture has resulted from the switch to gas carburizing from pack carburizing:

1. Production has increased due to shorter time in process, the reduction in rejects, and the elimination of excessive handling.

2. Continuous processing produces a more uniform product. Also, the tumbling motion of parts

HARDNESS GRADIENT SURFACE O.D. TO SURFACE I.D. GAS CARBURIZED PINS

Depth	Hardness, RC
o.d. surface	62/63
0.010 in.	63
0.020	59
0.030	55
0.040	49
0.050	41
0.060	37
0.075	39
0.085	45
0.095	52
0.105	59
0.115	63
i.d. surface	64

in retort permits even exposure of all surfaces to the gas carburizing atmosphere, resulting in a more uniform case.

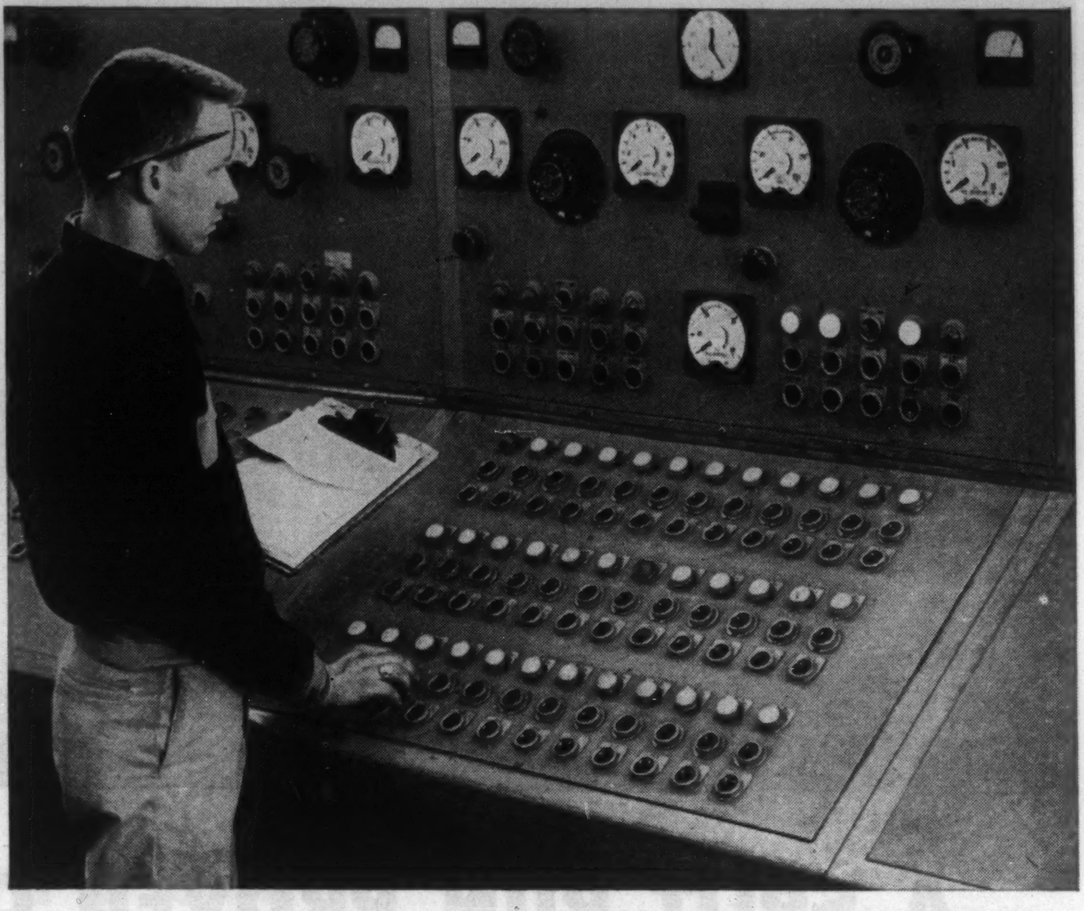
3. The reversing-rotating motion maintains a steady flow of just a few pieces at a time into the quench tank, providing better quenching action and uniform hardness on the entire surface of every pin.

4. The process yields uniform hardness from pin-to-pin, a production characteristic that is absolutely essential to the inherent interchangeability requirements of mass production.

now even better
invest more in
Defense Bonds

MALLORY·SHARON reports on

TITANIUM



What's this?

WE'RE MAKING METAL BY PUSHBUTTON!

● The familiar sights of steelmaking are strangely absent in a titanium plant. The melting crucibles must not only be completely enclosed, but maintained under vacuum, to prevent contamination of the molten titanium by gases. And the crucible requires special cooling, otherwise it would react with the titanium it holds.

In Mallory-Sharon's new titanium melting plant, production methods have been refined further, with all melting operations remotely controlled by pushbutton. This assures safety and provides the strictest control of processing possible. The result is consistently high quality and uniformity in the titanium and titanium alloy mill products which Mallory-Sharon produces.

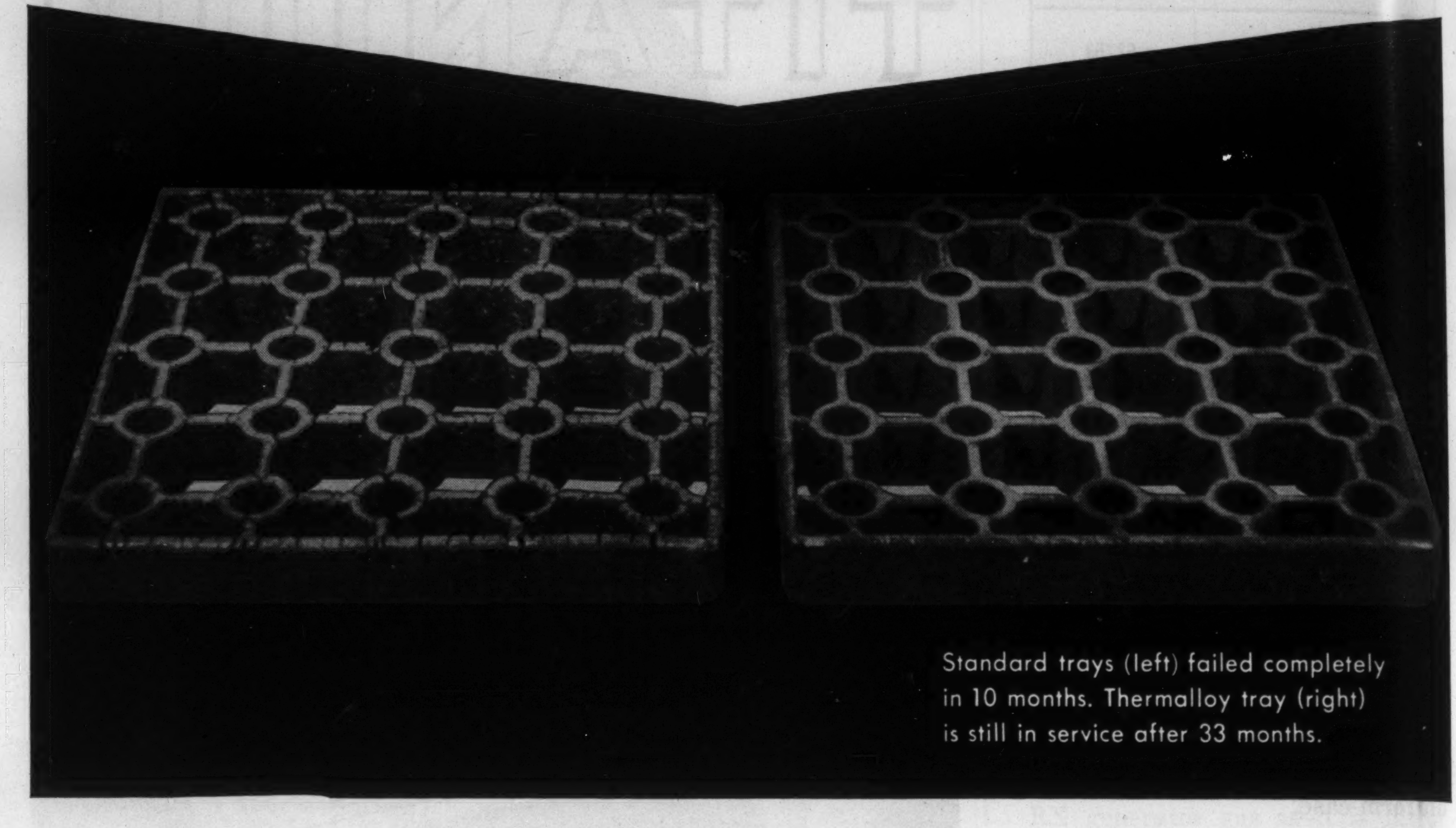
Mallory-Sharon's technical leadership, in research and production techniques, is good reason for you to call us in your applications of lightweight, corrosion-resistant titanium.

Mallory-Sharon Titanium Corporation, Niles, Ohio.

MALLORY Ti SHARON

For more information, turn to Reader Service Card, Circle No. 435

THERMALLOY* Application Engineering at Work



Standard trays (left) failed completely in 10 months. Thermalloy tray (right) is still in service after 33 months.

A SPLIT RUN PROVED OUR POINT!

Electro-Alloys offers engineering advantages unique in the high alloy field . . . because an experienced staff of engineers and metallurgists is available to help you design longer lasting heat-treat parts in Thermalloy.

Here's how our staff helped a large automotive manufacturer realize longer service from heat-treat trays used in carburizing service followed by oil quenching. Shown above are two types of trays used. One was of standard analysis. And the other tray was cast in a special analysis of heat-resistant Thermalloy . . . recommended by our staff after a careful study of job requirements.

We suggested that a split order of both trays be placed in identical carburizing service. The split run proved our point . . . the standard tray failed completely in 10 months, and the Thermalloy tray is still in service after 33 months.

Electro-Alloys engineering and metallurgical know-how has made a substantial difference in the life of many heat-treat and furnace parts. Can we help you? Call our nearest representative or write Elyria for Thermalloy General Catalog, T-225.

Constant research improves Thermalloy. Here, in tensile testing section, a strain indicator helps measure performance of Thermalloy up to the breaking point.

*Reg. U. S. Pat. Off.

AMERICAN **Brake Shoe** COMPANY

ELECTRO-ALLOYS DIVISION

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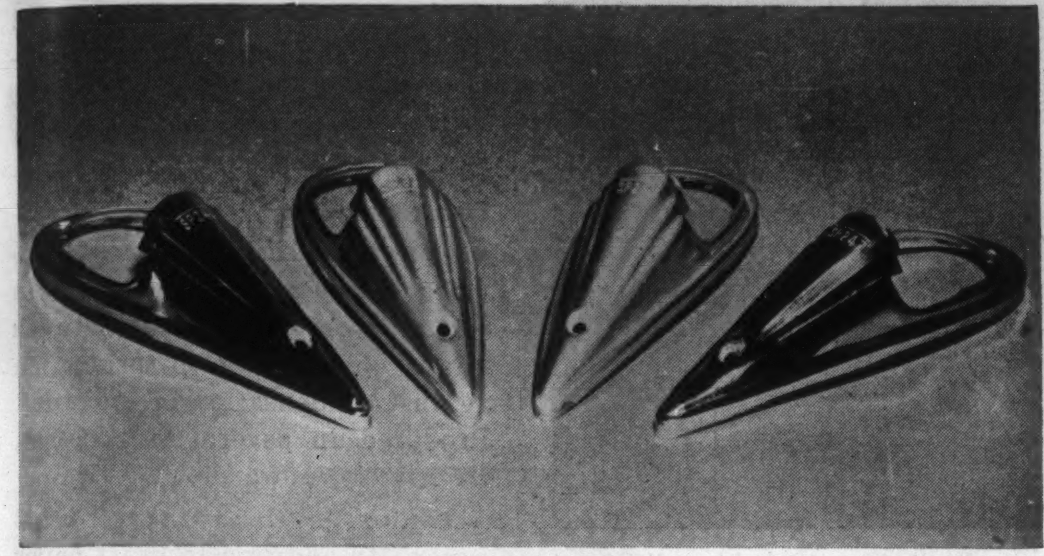
New Materials, Parts and Finishes | and related equipment



As-plated dull matte finish *is shown on two center parts, while other two have been buffed to high gloss.*

New Chromium Plate Needs No Undercoat

A new production chromium plating process has been developed which can deposit directly on steel with no copper or nickel undercoat required. The resulting plate is said to be free from cracks and other structural defects which have heretofore demanded a pre-coat to protect the underlying surface. Developed by *United Chromium, Inc.*, 100 E. 42nd St., New York 17, and called Crack-Free Chromium, deposits are said to have the following characteristics:

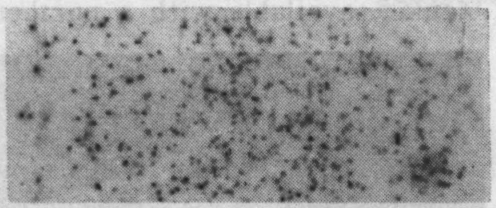
1. Much better corrosion resistance than that provided by ordinary chromium plated directly on steel, and the same corrosion resistance as that provided by commonly used composites of copper-nickel-chromium decorative finishes.
2. Remains crack-free when heated to 1000 F and plunged into water.
3. Softer and more ductile than ordinary chromium (500-700 Knoop as compared with 800-1000 Knoop hardness).
4. High degree of adhesion.
5. Improved non-galling, non-seizing and leveling properties. The latter characteristic aids in filling discontinuities, etc.

The major drawback to the process from the standpoint of decorative applications is the resulting dull matte finish produced. This can be buffed, however, to produce a high gloss.

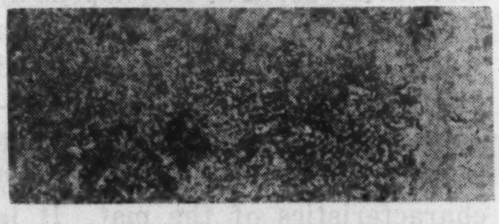
Plating can be carried out with conventional equipment and procedures. The bath is prepared by dissolving the proper amount of Unichrome SRHS Compound CF-500 in water, producing the special chromic acid type bath needed. The bath is said to be easy to operate and maintain. It has good throwing power, and plating speed is about the same as that of ordinary chromium plating.

In many trial industrial applications Crack-Free Chromium has been highly successful. One company, using the plate on cold stamping dies for embossing silverware, reported that the deposit gave 20% longer life than ordinary chromium. Another manufacturer reported that in punching aluminum tumblers in a series of draws, production difficulties due to the tumblers sticking and seizing in the dies were eliminated after plating dies with the new chromium plate.

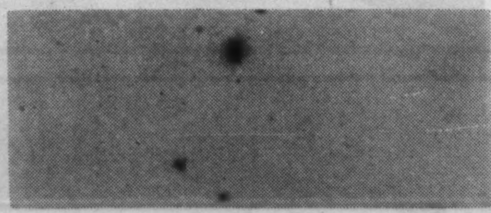
0.0002-in. Crack-Free Chromium



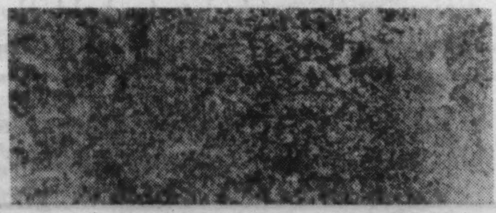
0.0002-in. Ordinary Chromium



0.0005-in. Crack-Free Chromium



0.0005-in. Ordinary Chromium



After 5-mo outdoor exposure, *these samples of chromium plated directly on steel show superiority of new plating process.*

New Materials, Parts and Finishes | and related equipment

Microlite can be easily fabricated *for applications such as air conditioners.*

Glass Mat With Various Facings

Two types of blanket materials consisting of glass fiber mat and various types of facing materials have recently been developed primarily for thermal insulation. By changing facings, however, the materials can be made adaptable for other uses.

Neoprene or vinyl facings

A blanket of glass wool made of small diameter fibers and faced with a thin coating of neoprene or vinyl plastics on one side is intended for thermal, vibration and acoustical insulation or as a moisture barrier. Developed by *Glass Fibers, Inc.*, 1808 Madison Ave., Toledo, Ohio, and called Microlite, the material has dimensional integrity provided by the coating, while retaining resilient characteristics of the mat. It is also available in the uncoated condition with a binder to hold the fibers together. In this condition it is fire-resistant.

Both coated and uncoated blankets are moisture-resistant, non-corrosive and light weight. The coated material is recommended for air conditioning installations; the plain blanket can be used where air velocities through ducts are less than 3000 ft per min. Uncoated material should be used where service temperatures are so high that the coating would be affected.

For thermal insulation the material has the following K coefficient (Btu transmitted/in. thickness/hr/sq ft/°F differential) at mean temperatures given:

Mean temp, F	50	75	100	150	200
K coefficient	0.20	0.21	0.23	0.27	0.31

Variety of facings

A similar type of glass fiber blanket, available with a number of facing materials, has been developed by *Owens-Corning Fiberglas Corp.*, 16 E. 56th St., New York 22, under the trade name Aerocor. It is primarily an insulating material to which properties such as greater strength, improved fire resistance, vapor barrier characteristics and heat and light reflectance can be added by selection of proper facing materials.

Aerocor with aluminum foil facing *acts as good vapor barrier and provides light and heat reflectivity.*

Aerocor is available with the following standard facing materials:

1. *Laminated kraft paper*—Provides moderate increase in strength. Asphalt coating between layers provides good protection against condensation of moisture. Produced in several thicknesses, from $1/2$ in. upwards.

2. *Reinforced laminated kraft paper*—In addition to kraft paper and asphalt laminates, material contains a scrim fabric or yarn of glass fibers to provide additional strength.

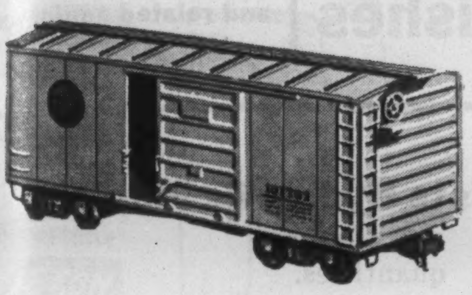
3. *Aluminum foil*—Three thicknesses are used—0.007, 0.001 and 0.0025 in., depending on strength required—as facings with bright side of foil outside. It provides good vapor barrier characteristics, light reflectivity of 90 to 95%, and good heat reflectance.

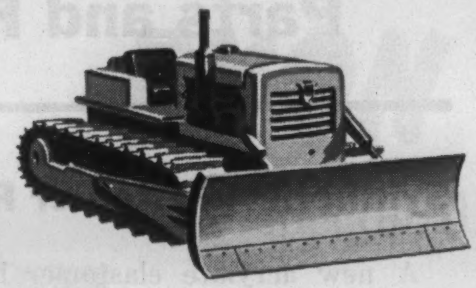
4. *Reinforced foil-faced kraft paper*—Facing consists of 0.001-in. aluminum foil bonded to flame-resistant kraft paper, with glass fiber scrim fabric interlayer. Strength is adequate for nailing or stapling; flame resistance and reflectivity is retained and the material serves as a vapor barrier.

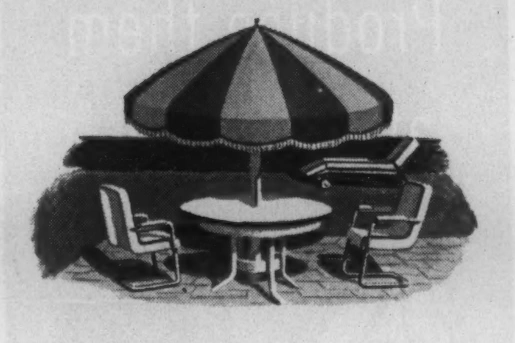
5. *Vinyl film*—Aluminum pigmented vinyl film, 0.004 in. thick, provides vapor barrier properties combined with heat reflectivity and self-extinguishing characteristics. It is said to have high strength with good resistance to tearing and scuffing.

6. *Reinforced polyester* — Results in light weight, rigid sheet material, said to be resistant to fire, water and water vapor and have good thermal insulating properties.

(More New Materials on p. 148)







MAKE IT WEIGH LESS
N·A·X
HIGH-TENSILE STEEL
MAKE IT LAST LONGER

You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel—it can be cold formed as readily into the most difficult shaped stamping.

When you next start to redesign, get the facts on N-A-X HIGH-TENSILE. It's produced by Great Lakes Steel—long recognized specialists in flat-rolled steel products.

N-A-X Alloy Division

GREAT LAKES STEEL CORPORATION

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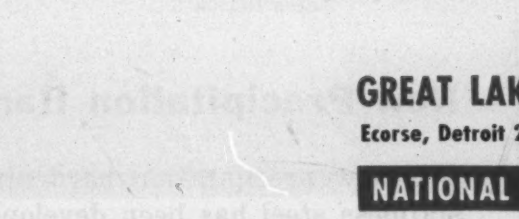

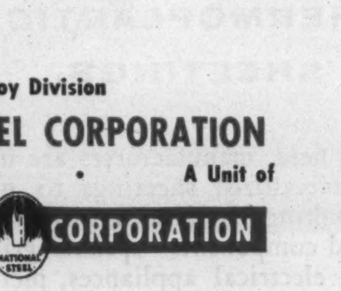

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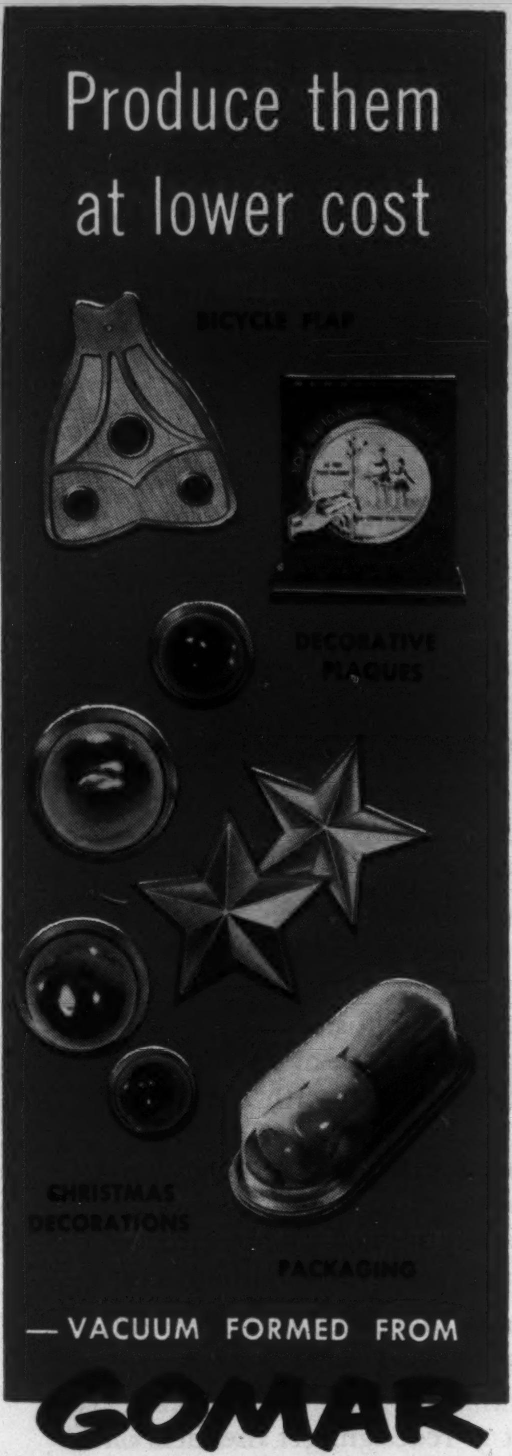

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METALLIZED THERMOPLASTIC SHEETINGS

In every field, manufacturers are using Gomar metallized sheetings to make better looking, far less expensive products and components—speaker grilles, trim for electrical appliances, picture frames, trademark plaques, dimensional replicas of metal products for display, toys and toy parts, costume jewelry, ornaments, packaging and novelties.

This amazing, tough plastic looks like metal, retains its brilliant finish indefinitely. Saves production costs because it eliminates costly metal plating of clear plastic. In gold, silver, bronze, copper, steel, aluminum colors; and metallic reds, greens, blues, and yellows.

Send for free color chart and literature.

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New Materials, Parts and Finishes

and related equipment

Synthetic Elastomer Resists Hydraulic Fluids

A new acrylate elastomer has been developed principally for packings in hydraulic systems. Due to its resistance to swelling and attack it can be used in conjunction with either petroleum or ester-based hydraulic fluids. The elastomer, called Vyram, can be fabricated into standard packings and gaskets using conventional rubber processing equipment according to the manufacturers, *Monsanto Chemical Co.*, 1700 S. Second St., St. Louis 4, Mo. Now in pilot plant production, the material is available in interim quantities.

Though its main deficiency seems to be stiffening at extremes of temperatures, additional study is expected to result in improved low temperature performance, better aging, lower compression set and shorter cure times. An accompanying table lists typical physical properties of optimum formulations. Other future applications might include hose liners, wire coatings, and use as an impregnating material for specialty fabrics where chemical resistance is necessary.

TYPICAL PROPERTIES OF CURED VYRAM

Typical Original Properties:		
Shore "A" Hardness	75	
Ultimate Tensile Strength, psi	1333	
Elongation, %	346	
Compression Set (Method B, 25% deflection)	% of thick.	% of defl.
70 hr at 212 F	20.0	75.0
Tear, lb/in.	178	
Low Temperature Brittleness	Pass: 14 F Fail: 5 F	
Properties After Aging at 212 F:	48 hr	72 hr
Tensile, psi	1440	1683
Elongation, %	286	240
Ozone Resistance	Excellent. No visible cracking after 1000 hr at 25 pphm ozone in static and dynamic tests.	

Formulation: *Vyram* 141
Stearic Acid 3
Magnesium Oxide 20
Lead Dioxide 5

Cure: *30 to 60 min at 330 F*

New Precipitation Hardening Stainless Steel

A new precipitation hardening stainless steel has been developed to bridge the gap between the 300 and 400 series, both in respect to composition and method of heat treatment. It can be hard-

PROPERTIES OF ALLEGHENY METAL 350[a]

Condition	Hardness	0.2% Yield Strength, psi	Tensile Strength, psi	Elongation in 2 in., %	Charpy V Notch Impact Strength, ft-lb		Stress to Rupture in 1000 hr at 900 F, psi
					Room Temp	—40 F	
Annealed	93 Rb	44,900	163,700	22	110	—	—
Sub-zero Cooled	43 Rc	118,000	200,000	10.0	—	55	—
Sub-zero Cooled and Tempered	42 Rc	147,700	193,200	13.5	51	36	92,000
Double-Aged	38 Rc	142,700	171,500	11.5	23	15	86,000
Full Hard Type 301	—	140,000 min	185,000 min	9 min	—	—	—

[a] *All data obtained on sheet material—with the exception of Impact Strength, which was obtained from bars hardened to a comparable hardness.*

EXON: each resin engineered for a specific problem

EXON 468

specifically for

flooring

Firestone
EXON
468

Higher bulking density of EXON 468 increases the banbury output 10 to 25%! It makes processing easier, since it permits fast fusion at reduced temperatures.

A superior resin in every respect, EXON 468 offers good heat and light stability, high thermoplasticity, compatibility with conventional vinyl plasticizers, stabilizers and pigments.

Used as the base resin in vinyl asbestos floor tile formulations, EXON 468 provides new production economies — and superior end products.

For suggestions on developing new products, or improving established ones with EXON 468—or for complete information or technical service on the growing line of versatile EXON resins, contact:

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DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY

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+600°F

Acushnet

SILICONE
PRECISION-MOLDED
RUBBER PARTS

SUPPLEMENT "B"
to
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DATA HANDBOOK
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Acushnet's unique Custom-Compounding Method is a notable simplification in the processing of Silicone Rubber • By formulating our own compound to arrive at the specific property or properties required for each individual application, each order can now be tailor-made to fit the customer's own specifications. Result: improved product, and in many cases lower cost.

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NEW BEDFORD, MASSACHUSETTS, U. S. A.
Precision-Molded RUBBER *Parts & Products*

−140°F

SILICONE RUBBER *Custom-Compounded* TO MEET *Your Own* SPECIFICATIONS

Acushnet's Custom-Compounding Method is a notable simplification in the processing of Silicone Rubber, the remarkable material that resists temperature extremes from +600°F to −140°F.

By using the versatile Silicone *gums,* we formulate our own compound to obtain the specific property or properties required for each individual application. This eliminates large inventories and involved "doctoring" of standard premixed stocks.

Many times, a lower cost formulation can be used which will perform in the particular application as well or better than any available pre-mixed stocks.

Each order can now be tailor-made to fit the customers' own specifications or requirements. As a result, production time is shortened, better product performance is obtained, and in many applications the cost is reduced.

When customers still specify a standard stock suitable for application we gladly produce the required part.

Acushnet

Send for a copy of the Silicone Rubber parts brochure illustrated above — an interesting, informative compilation of Silicone Rubber Data, with illustrations and descriptions of typical and unusual applications.

Acushnet Rubber Data Handbook also available on request.

ACUSHNET PROCESS COMPANY

Address all communications to 750 Belleville Ave., New Bedford, Mass.

For more information, turn to Reader Service Card, Circle No. 385

ened by sub-zero cooling followed by tempering, or hardened by double-aging. Hardening by sub-zero cooling permits fabrication while in the annealed state, and hardening at temperatures low enough to preclude scaling and distortion. Chemical composition of the steel is 17 chromium-4.2 nickel-0.08 carbon-0.60 manganese-0.40 silicon-2.75% molybdenum. Called Allegheny Metal 350 (AM-350) the steel has been developed by *Allegheny Ludlum Steel Corp.*, Oliver Bldg., Pittsburgh, Penna.

The major difference between the 400 and 300 series of stainless steels lies in the degree of austenite stability. AM-350 occupies an intermediate position between austenitic and hardenable steels. The stability is achieved by a proper balance of component elements and is such that the temperature of transformation of austenite to martensite is located below room temperature.

Two methods of hardening

After annealing in a manner similar to standard austenitic steels, AM-350 can be hardened by cooling to a temperature of -80 to -100 F. For maximum strength and ductility, cooling must be followed by a 1- to 2-hr tempering at 750 to 900 F. Because of the low temperatures, scaling and distortion do not occur and the 750 F temperature results in only slight discoloration.

An alternate hardening method involves a two stage precipitation-hardening treatment called double-aging. A 1- or 2-hr treatment at 1300 to 1400 F results in precipitation of chromium carbides, altering the austenite so that it transforms to martensite on cooling to room temperature. A second treatment of 1 or 2 hr at 800 to 900 F provides a further increase in hardness and strength.

Physical properties

Mechanical properties of a typical heat of AM-350 in various conditions are shown in an accom-

Bundy design increases production on accelerator rods—saves 45% on costs

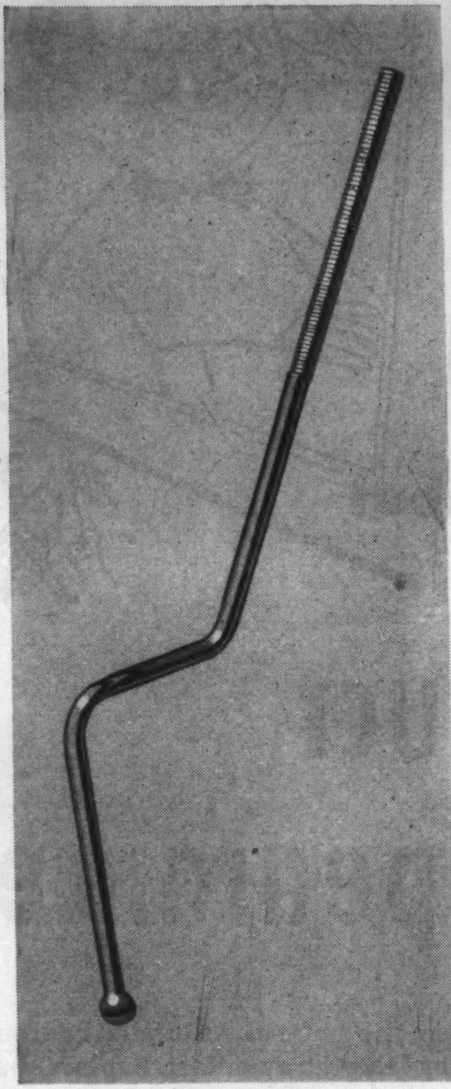
At right is a typical example of how Bundy can operate to help you in your design needs. In this application, the solution to the problem of accelerator rod production was not only simplified design, but a remarkable cost savings of 45%!

Why not check with us in your own tubing design needs? When you call in a Bundy Engineer at the design stage of your product, you can be assured of successful results. As the leading manufacturer of small-diameter tubing, Bundy has developed an engineering staff of experts who can tackle and help solve your most difficult problems.

Find out about the high quality of Bundyweld Tubing. Remember, Bundyweld is the only tubing that is double-walled, yet stronger. It has high thermal conductivity, high bursting strength, is leakproof, and takes easily to any fabrication operation. Bundyweld is the safety standard of the refrigeration industry, *and is used in 95% of today's cars, in an average of 20 applications each.*

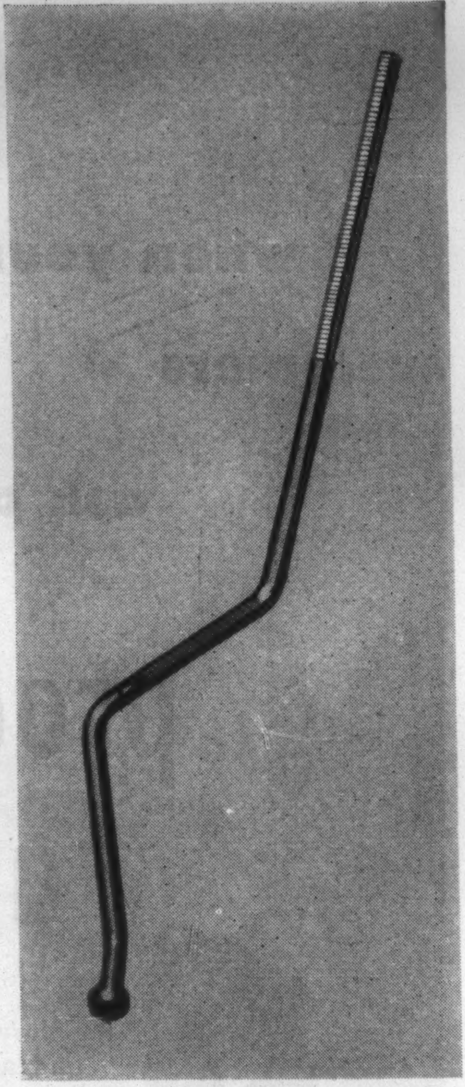
For further information, call, write, or wire us, today.

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN



PROBLEM:

Building a light touch into an automobile accelerator used to be an expensive proposition. Rod linkage has to be rigid and precisely machined. For example, the solid steel rod shown above had to be forged into a ball on one end, machined and threaded on the other, and bent to a precise configuration on a press. These operations were very costly.



SOLUTION:

The simplified Bundy design started with a piece of ¼″ O.D. Bundyweld. A spherical end is formed by automatic press at a high production rate. The other end is swaged and roll threaded, and the rods are bent to specifications on hand fixtures. Result: accelerator rods were produced at 45% savings in cost, at a higher rate of production than the old way.

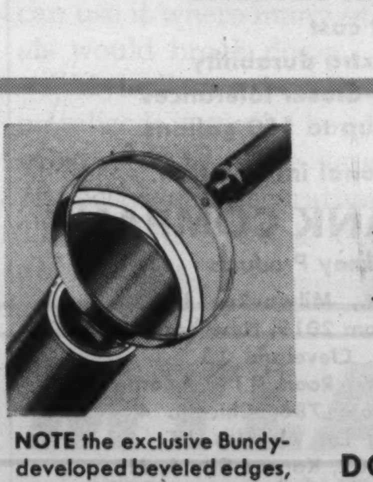
Bundyweld starts as a single strip of copper-coated steel. Then it's

. . . continuously rolled twice around laterally into a tube of uniform thickness, and passed

through a furnace. Copper coating fuses with steel. Result . . .

SIZES UP TO ⅝″ O.D.

Bundyweld, double-walled and brazed through 360° of wall contact.



NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP

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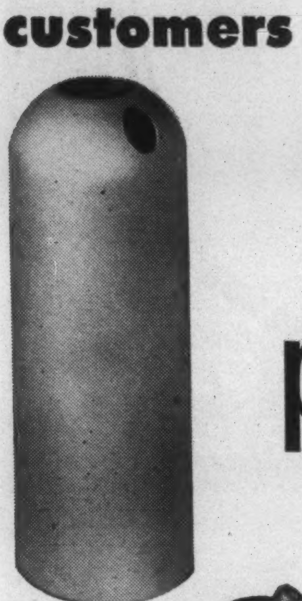
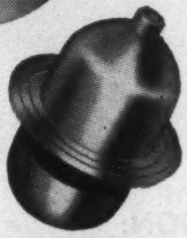
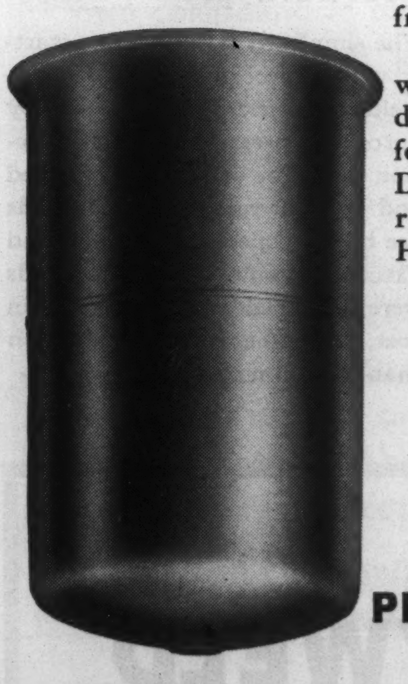
when your customers ask about

product appearance...







Show them the smoothly rounded contours of a Hackney Deep Drawn Part. Explain that the deep drawing process produces extra smooth surfaces—that minimum seam area results from this type of design.

These are some of the attractive features which other manufacturers have been able to design into their products by replacing a cast, forged or welded pipe part with a Hackney Deep Drawn Shape or Shell. If you are redesigning for better appearance, these Hackney features may help you.

In addition, Hackney Parts may increase product value through one or more of the following advantages:

Lower unit cost
Greater strength—Extra durability
Lower over-all weight—Closer tolerances
In sizes from one quart up to 150 gallons.

Write today for additional information.

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Manufacturer of Hackney Products
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52 Vanderbilt Avenue, Room 2019, New York 17
241 Hanna Bldg., Cleveland 15
936 W. Peachtree St., N. W., Room 111, Atlanta 3
208 S. LaSalle St., Room 788, Chicago 4
559 Roosevelt Bldg., Los Angeles 17
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Hackney MILWAUKEE

DOWNINGTOWN IRON WORKS

DOWNINGTOWN IRON WORKS, INC., DIVISION
136 Wallace Ave., Downingtown, Pennsylvania

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

For more information, turn to Reader Service Card, Circle No. 434

panying table. Though it is relatively soft and ductile and can be readily fabricated in the annealed condition, hardness is increased to 40 Rc or greater by sub-zero cooling; tensile properties are equivalent to Type 304 in the half-hard condition. In the subzero cooled and tempered condition, the alloy is said to have tensile properties in excess of minimum specifications for full-hard Type 301.

Properties gained by double-aging are somewhat inferior to those obtained by sub-zero cooling and tempering. Lower ductility is a direct consequence of carbide precipitation required in double-aging. AM-350 resists softening by tempering, and is said to maintain high strength at temperatures up to 1000 F.

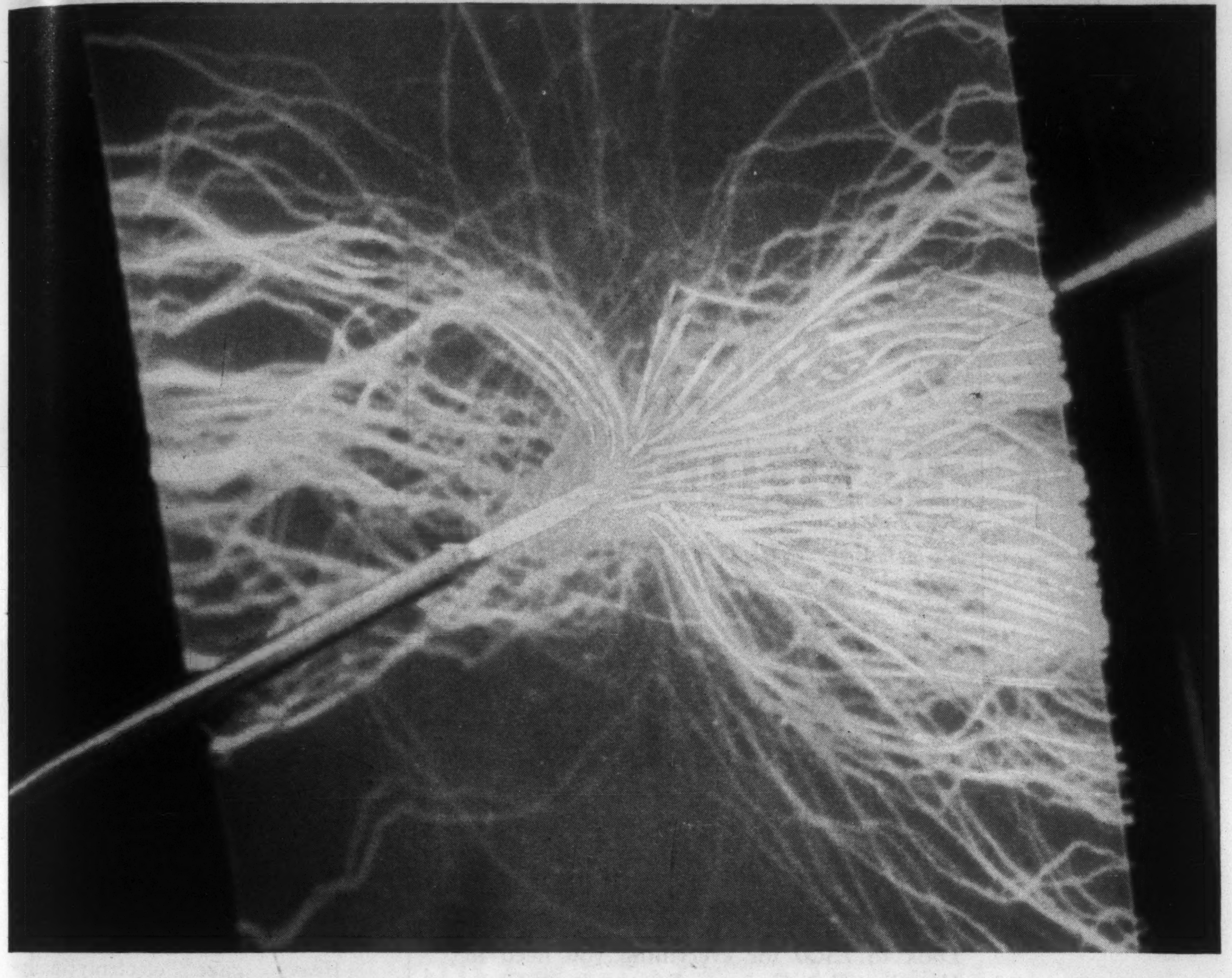
Corrosion resistance of the alloy after hardening by cooling and tempering is comparable to that of Type 316 and superior to that of Type 304 in boiling glacial acetic acid and 1% sulfuric acid at 100 F. Maximum resistance to boiling 65% nitric acid is obtained when in the sub-zero cooled condition without tempering. Nitric acid rates are greater than Type 304's, but less than those of other hardenable stainless steels such as Type 410. Corrosion resistance in all media is poorer in the double-aged condition than when sub-zero cooled and tempered.

Resistance to pitting type attack in 20% sodium chloride salt spray test is said to be high. Samples hardened in both manners have passed a 3000-hr stress corrosion test in a 20% salt spray and a 1-hr test in a 0.1% selenium dioxide-1:1 hydrochloric acid solution.

Applications

One of the most important applications foreseen for the alloy is in commercial and military aircraft construction. It can be worked in the annealed condition and strengthened by non-distort-

ASTOUNDING... the insulating ability of this thin plastic film



CHALLENGING to industry... the combination of remarkable properties offered by Du Pont MYLAR*

The photograph above can mean something to you even if your product has nothing to do with electricity. A high-voltage blast passes around, rather than through, a thin sheet of new Du Pont "Mylar" polyester film. High dielectric strength—essential for any insulating purpose.

But that's just *one* of the many unusual properties offered by this new film.

"Mylar" is the strongest of all plastic films available. Important if you want to design miniaturized equipment, or need extra toughness and thinness for any purpose.

"Mylar" keeps its remarkable properties over a wide temperature range. Vital if your product operates under extremes of heat or cold.

"Mylar" resists the attack of many acids, bases, organic solvents. You can use it where many other materials would break down.

"Mylar" can be slit into yarn; metalized; it can be bonded to other substances to make vapor barriers, protective and decorative laminates. This opens a whole new range of applications.

DU PONT

MYLAR®

POLYESTER FILM

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Better Things for Better Living ... *through Chemistry*

What about *your* product? It may pay you to find out about the amazing variety of products in which "Mylar" has already cut costs and increased efficiency. Send for your copy of a new fact-filled booklet and samples of this versatile new film. Mail the coupon below.

"Mylar" is a registered Du Pont trade-mark for its brand of polyester film

E. I. du Pont de Nemours & Co. (Inc.)
Film Department, Room 6T, Nemours Bldg.
Wilmington 98, Del.

Please send me sample and further information on "Mylar" polyester film.

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Firm____________________________

Street Address______________________

City________________ State________

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HASTELLOY B&C
SUPER ALLOY CASTINGS
fight CORROSION
from hydrochloric acid
phosphoric acid
sulphuric acid
and many other corrosives

Look to *ESCO* for everything you need in Hastelloy B & C super alloy castings. Conventional, Shellcast and centrifugal castings are available to meet your most exacting requirement. You get prompt delivery—even on small orders.

Hastelloy fittings are available from stock— standard flanged, screwed and welded fittings can be delivered fast from conveniently-located warehouses.

Look to *ESCO* for everything you need in stainless and high alloy steels. Ask our high alloy engineers to make a complete study of your corrosion problems. Call your nearest *ESCO* office for details.

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HIGH ALLOY DIVISION

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Houston, Texas
Eugene, Oregon
Salt Lake City, Utah
Honolulu, Hawaii
in Canada: Vancouver,
British Columbia and
Toronto, Ontario.

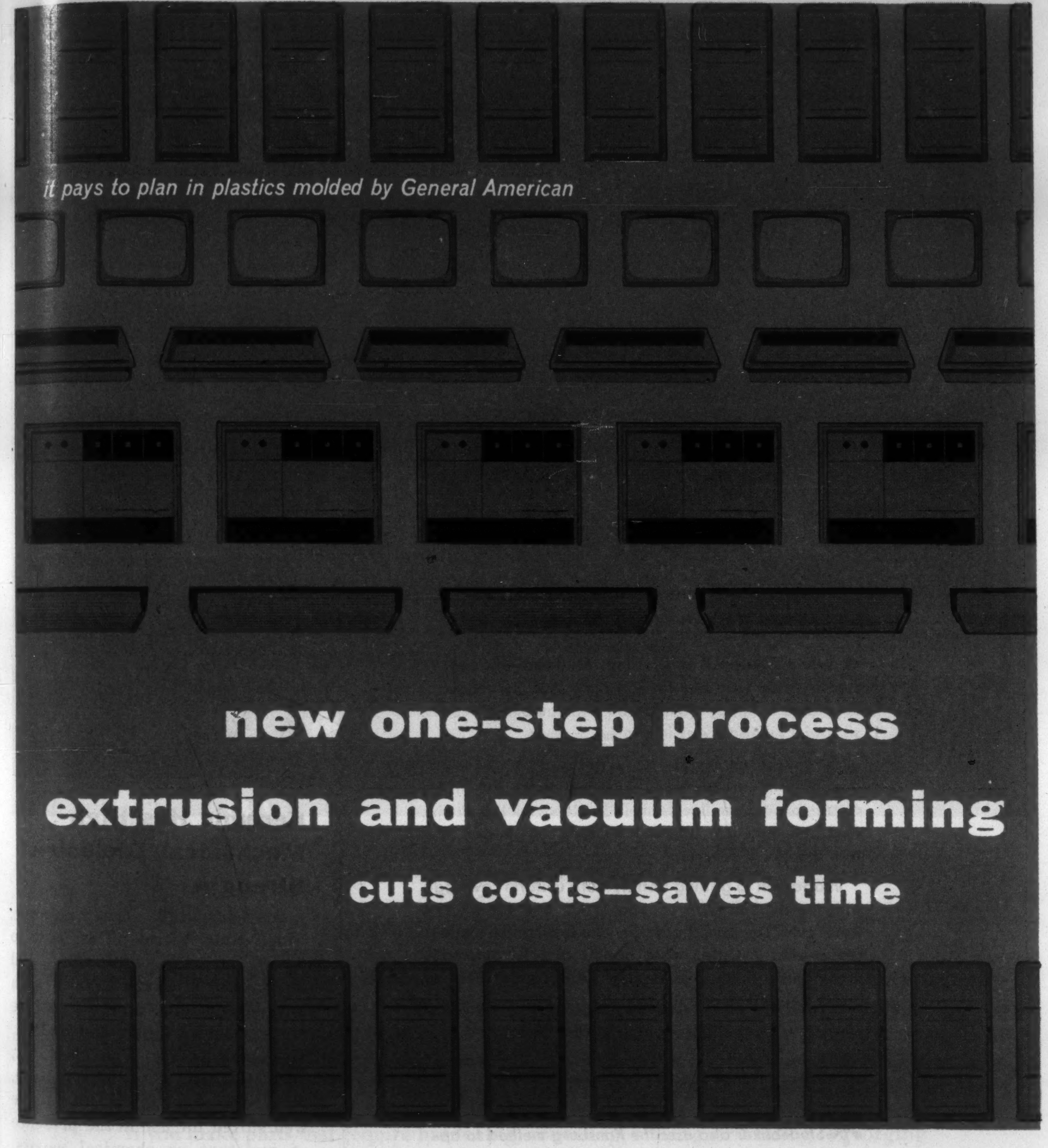
For more information, turn to Reader Service Card, Circle No. 483

ing treatment at low temperatures. Other applications include diaphragms, flat and coiled springs, corrosion resistant fasteners, dental and surgical equipment, saws and saw blades, piston rings, glass molds, pump parts, camera parts and cutlery.

Heavy Gage Tin Plate Cuts Production Costs

Heavy gage electrolytically-coated tin plate is being produced by *Jones & Laughlin Steel Corp.*, 3 Gateway Center, Pittsburgh 30. Advantages claimed for the matte-finish tin plate are: 1) good surface condition for subsequent plating, painting, and finishing; 2) good deep drawing qualities; 3) no need for degreasing by customer; 4) uniformity of gage; 5) uniform ductility; 6) uniform coating thickness; 7) longer die life resulting from lubricating properties of tin; 8) weight saving on finished parts formerly made of terne plate; and 9) lower material costs when substituted for many metals.

J&L is now producing the plate in three coating weights: No. 25, with a tin coating of ¼-lb per base box (217.8 sq. ft); No. 50, with ½-lb per base box; and No. 75 with ¾-lb per base box. It is available in coils 22 to 32 in. wide, as heavy as 22 gage, and in



new one-step process extrusion and vacuum forming

cuts costs—saves time

Refrigerator inner-door liners by the thousands, television-cabinet fronts, dresser drawers, air conditioner fronts, housings for lighting fixtures . . . these are just a few of the many parts that can be produced in one step at lower cost through General American's continuous operation extrusion and vacuum forming.

This General American process speeds production, permits lower tooling costs, more rapid tooling and quicker changeover. With General American doing your molding, you have no capital investment.

Can these advantages help you? It will pay you to find out. Investigate General American's unduplicated facilities for plastics moldings. Write for details.

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Facilities unmatched anywhere: injection, compression, extruding and vacuum forming, reinforced plastics, painting and assembling

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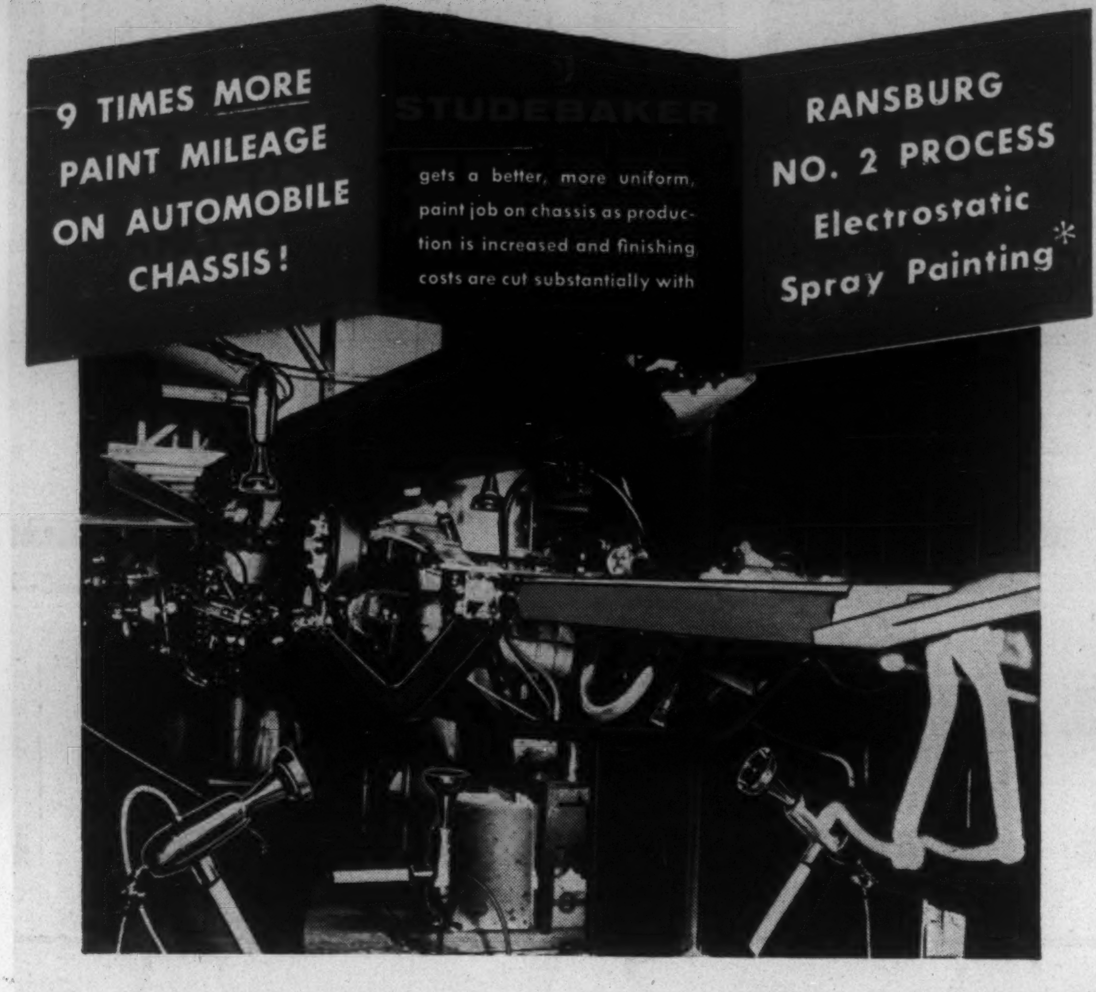

9 TIMES MORE PAINT MILEAGE ON AUTOMOBILE CHASSIS!
STUDEBAKER
gets a better, more uniform, paint job on chassis as production is increased and finishing costs are cut substantially with
RANSBURG NO. 2 PROCESS Electrostatic Spray Painting*

● When Studebaker Division, Studebaker-Packard Corporation switched to Ransburg No. 2 Process of Electrostatic Spray painting on their automobile chassis, paint mileage was increased 9 times.

By simply putting the paint where it's supposed to go, Studebaker cut daily paint consumption on the chassis production line from 14½ drums to 1½ drums. And, still they are painting 6 more chassis per hour with the No. 2 Process.

In addition to getting better, more uniform coverage with the asphalt-type coating, paint and labor costs were cut 70¢ per chassis. In eliminating the former set-up with 2 water wash booths and 12 automatic spray guns, they save nearly 1000 square feet of badly needed floor space.

Another on-the-job-example of the unmatched efficiency of the Ransburg No. 2 Process in which quality of the work is improved . . . AT LESS COST!

* *Studebaker also uses the Ransburg method to apply a heavier and more uniform primer surfacer on automobile bodies.*

Whatever your product—large or small—if your production justifies conveyorized painting, it's possible that one of the Ransburg electrostatic processes can do the job better, with substantial savings to you. We'll be glad to tell you about complete Ransburg services.

Write to Dept. M.

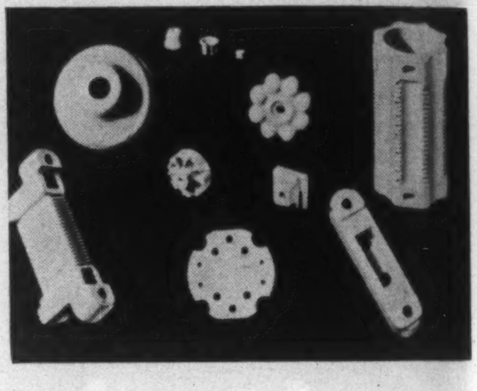
Ransburg ELECTRO-COATING CORP.
Indianapolis 7, Indiana
RANSBURG

For more information, turn to Reader Service Card, Circle No. 395

New Materials, Parts, Finishes

cut lengths up to 120 in. long.

Where corrosion is not too great a factor, tin plate can be used as replacement for long ternes, aluminum, zinc-coated sheets and other metals of higher cost. Heavy gage tin plate has been used to replace long ternes in parts such as automotive air and oil filters, engine parts, outboard motors, etc. It can be used in venetian blind hardware, building specialties and radio and television parts.



Ceramic Has High Mechanical, Dielectric Strength

A feldspathic type ceramic, called Star Vitrolain, is said to have superior dielectric and mechanical strength as well as a low pore volume and a moisture absorption of less than 0.25% Marketed by *Star Porcelain Co.*, 151 Muirhead Ave., Trenton 9, N. J. the material is said to be well suited for use in the presence of moisture or chemical vapors. It is available in white as well as a range of color glazes.

Four New Tapes

Four new tapes have been developed recently by three manufacturers: 1) glass fiber tape designed for underground pipe wrapping; 2) Mylar tape designed for electrical applications; 3) pressure-sensitive vinyl electrical tape; and 4) pressure-sen-

Ten Million TOCCO*-Hardened Axle Shafts

Battery of TOCCO machines for hardening automotive axle shafts. TOCCO*-hardened shafts show an increase of up to 200% in resistance to torsional fatigue over furnace-hardened shafts made of alloy steel.

Give Super Service to American Motorists

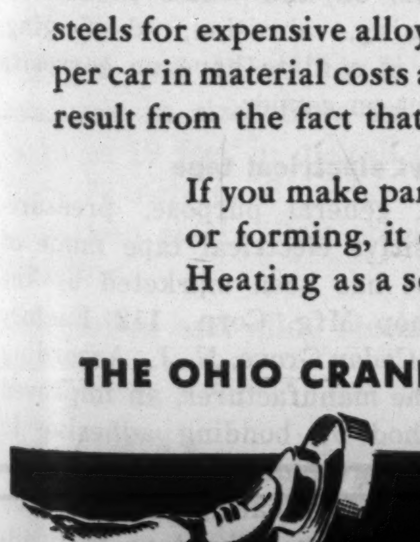
...Save Manufacturers $2,000,000

The application of TOCCO* Induction Heating to the surface hardening of rear axle drive shafts for passenger cars and trucks provides a fine example of how a less expensive manufacturing method often results in the best possible end product.

For instance, TOCCO* Induction Hardening permits the substitution of easier machining carbon steels for expensive alloys, saving from 25¢ to 55¢ per car in material costs alone. Additional savings result from the fact that TOCCO eliminates the need for annealing, tempering and shot peening operations formerly required. Moreover, long hauls to and from the heat-treating department are eliminated because cool, clean TOCCO* fits right in the production line—next to related operations.

If you make parts that require hardening, annealing, brazing, or heating for forging or forming, it can pay you handsome dividends to investigate TOCCO* Induction Heating as a sound method of improving product quality *while reducing costs.*

THE OHIO CRANKSHAFT COMPANY



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*Trade Mark Reg. U. S. Pat. Off.

Mail Coupon Today

NEW FREE BULLETIN

THE OHIO CRANKSHAFT CO.
Dept. T-6, Cleveland 1, Ohio

Please send copy of "Typical Results of TOCCO Induction Hardening and Heat Treating."

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Company___________________________
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City____________Zone____State________

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Have you anything to MOLD in NYLON?

Pictured are a few of many Nylon parts SINKO has molded for some of America's leading manufacturers

SINKO, a pioneer in Nylon Molding, is now supplying a great many industries with parts made of this remarkable plastic material. Nylon has properties that are highly desirable, especially in mechanical parts; and tends to improve and develop the products in which molded Nylon parts are used.

Check these outstanding Nylon characteristics:
- √ Unusual strength and resiliency
- √ Resistance to wear, to impact, and to shock loads
- √ Endurance to abrasion, corrosion and prolonged immersion
- √ Attractive appearance and long life
- √ Withstands effects of chemicals and excessive temperatures
- √ Silent and self-lubricating

SINKO molds all other Thermoplastic Materials, including the remarkable new KEL-F . . . in sizes from 4 to 60 oz. A highly skilled staff of specialists, using the latest in modern equipment, will manufacture your injection molded parts and products with the utmost in accuracy, speed, and economy.

Our services include Design and Engineering; Mold Construction; Metal-Plastic Assemblies; 2 and 3 color Plastic Spraying and Painting; Hot Stamping; Vacuum Distillation Plating; Fabricating and Assembling.

√ Check with us on your Nylon and other Plastic Molding applications . . . we'll be glad to furnish you with test samples!

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For more information, turn to Reader Service Card, Circle No. 389

New Materials, Parts, Finishes

sitive glass cloth tape for Class H insulation.

Glass fiber pipe wrap

Economy and ease of application are two features claimed for Duratape, a glass fiber bonded mat incorporating glass yarn reinforcing and a coating of plasticized coal tar on both sizes. The tape is nominally 0.070 in. thick and has a tensile strength of 29 lb per in. Developed by the *Mat Div., Glass Fibers, Inc.*, 1810 Madison Ave., Toledo 2, Ohio, the tape is pliable, making it suitable for application on irregular contours. It is recommended as a dielectric barrier against electrolytic corrosion on field joints, as fittings on oil and gas transmission and distribution lines, and for patching existing coatings.

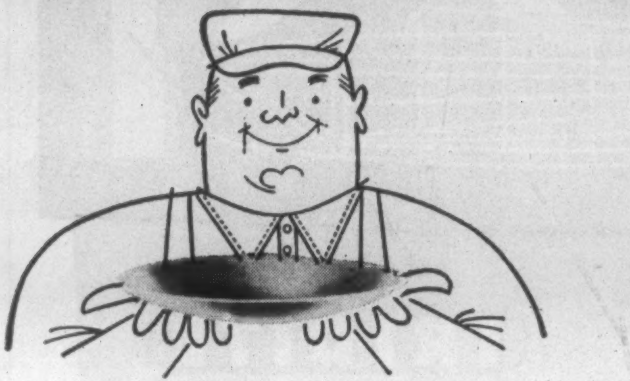
Mylar electrical tape

A tape consisting of Mylar polyester film and an inorganic silicone adhesive has been marketed by *Mystik Adhesive Products*, 2635 N. Kildare Ave., Chicago 39. Designated Mystik No. PD 300, the pressure sensitive tape is said to have a dielectric strength of 9000 v, with an electrolytic corrosion factor of less than 1.0. The tape is resistant to solvents, oil and water immersion, staining, abrasion, shelf-aging, and is said to have no corrosive effect on copper.

Vinyl electrical tape

A general purpose, pressure-sensitive electrical tape made of vinyl has been marketed by the Bishop Mfg. Corp., 112 Factory St., Cedar Grove, N.J. According to the manufacturer, an improved method of bonding adhesive to vinyl precludes transfer of adhesive, eliminating tackiness on the backing. The tape is available in thicknesses of 7 and 10 mils with dielectric strengths in excess of 10,000 and 13,000 v respectively. Insulation resistance of both tapes is over 200,000 megohms. Tapes are available in

CLAYMONT FLANGED AND DISHED HEADS



from 9 inches

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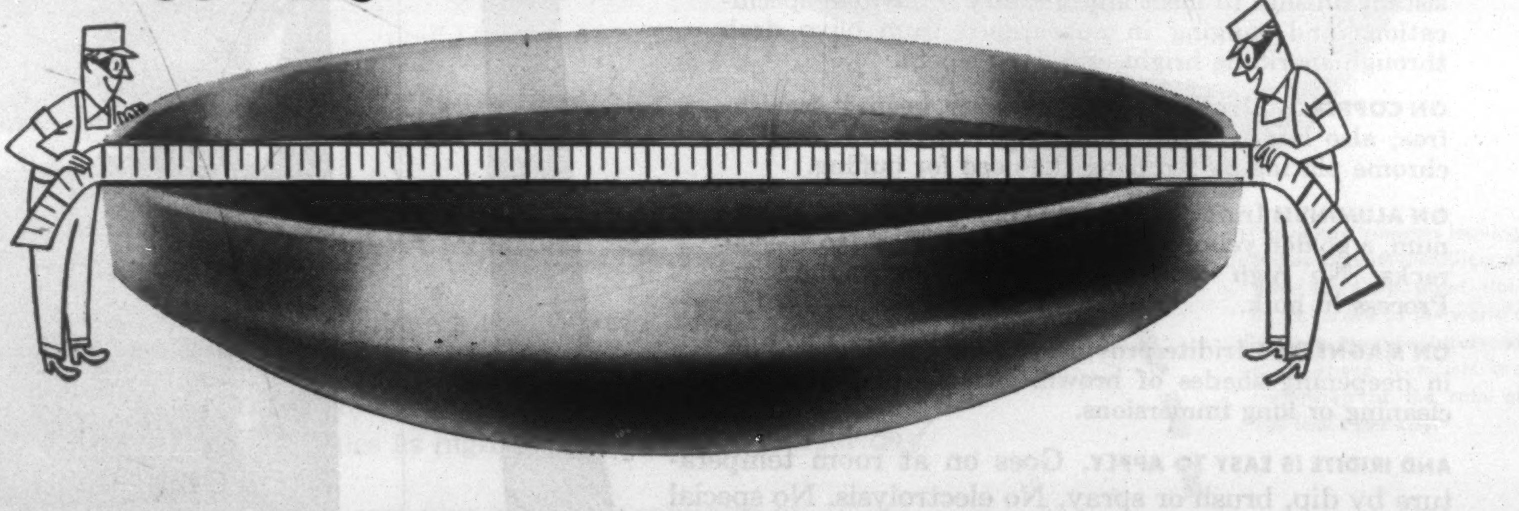
to 19 feet in diameter



Flanged and dished heads made by Claymont are available in sizes from as small as 9 inches to as large as 19 feet in overall diameter; and in gauges from 3⁄16-inch to 6 inches. They can be supplied in carbon steel, alloy steel or with stainless steel cladding.

All carbon and alloy steels are the product of our own open hearth furnaces—closely and completely controlled to meet customers' specifications.

We are also prepared to handle head-forming operations on both ferrous and non-ferrous metal supplied by the customer. To order, write or call Claymont Steel Products Department, Wickwire Spencer Steel Division, 813 West Street, Wilmington 99, Delaware.

Claymont Steel Products

Products of Wickwire Spencer Steel Division • The Colorado Fuel and Iron Corporation

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Other Claymont Products **. . . Carbon and Alloy Steel Plates • Stainless-Clad Plates • Manhole Fittings and Covers • Large Diameter Welded Steel Pipe • Flame Cut Steel Plate Shapes**

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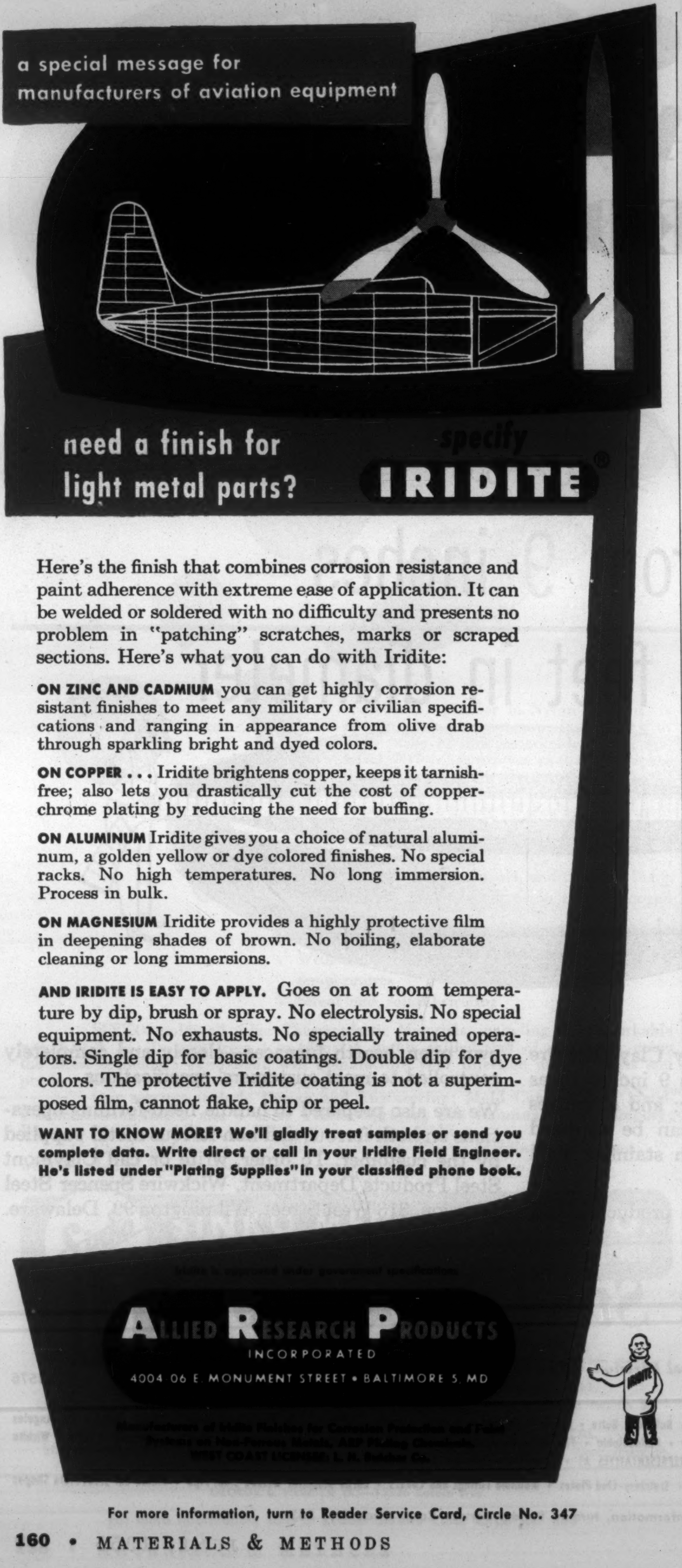
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need a finish for light metal parts?

specify **IRIDITE**®

Here's the finish that combines corrosion resistance and paint adherence with extreme ease of application. It can be welded or soldered with no difficulty and presents no problem in "patching" scratches, marks or scraped sections. Here's what you can do with Iridite:

ON ZINC AND CADMIUM you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.

ON COPPER . . . Iridite brightens copper, keeps it tarnish-free; also lets you drastically cut the cost of copper-chrome plating by reducing the need for buffing.

ON ALUMINUM Iridite gives you a choice of natural aluminum, a golden yellow or dye colored finishes. No special racks. No high temperatures. No long immersion. Process in bulk.

ON MAGNESIUM Iridite provides a highly protective film in deepening shades of brown. No boiling, elaborate cleaning or long immersions.

AND IRIDITE IS EASY TO APPLY. Goes on at room temperature by dip, brush or spray. No electrolysis. No special equipment. No exhausts. No specially trained operators. Single dip for basic coatings. Double dip for dye colors. The protective Iridite coating is not a superimposed film, cannot flake, chip or peel.

WANT TO KNOW MORE? We'll gladly treat samples or send you complete data. Write direct or call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified phone book.

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Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals, ARP Plating Chemicals.
WEST COAST LICENSEE: L. H. Butcher Co.

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New Materials, Parts, Finishes

20- and 66-ft and 36-yd roll lengths and widths to meet a variety of service requirements.

Class H insulating tape

A new glass cloth tape with silicone pressure-sensitive adhesive on both sides has been developed for Class H insulation by *Mystik Adhesive Products*, 2635 N. Kildare Ave., Chicago 39. Mystik Brand No. 7100 is said to bond tightly at temperatures ranging from -100 to 550 F. Dielectric strength is 4000 v minimum; it is non-toxic, inorganic and highly resistant to aging, acids, oils, staining and water and oil immersion. Dry tensile strength tests indicate a minimum of 150 lb per in. of width.

New Silicone Rubbers for Low Temperatures

Two new Silastic stocks for low temperature service have been developed by *Dow Corning Corp.*, Midland, Mich. Designated S-2048 and S-6526, they were designed specifically for aircraft seals and low temperature applications. Both are white and may be extruded, molded or calendered. They are available at prices comparable to those of standard silicone rubbers.

Silastic S-2048, a 60 durometer stock, has good flame resistance, resilience at -130 F, high mechanical strength and can be

Plastic toy trumpets leaving Stokes Vacuum Metallizer at Ideal Toy Corp. plant, Hollis, N.Y., one of the world's largest manufacturers of toys. These trumpets are metallized at the rate of 100 loads per day.

Vacuum Metallize for Profit with Stokes Automatic Metallizers

Many Stokes customers are vacuum metallizing for sales-appeal on items as diverse as toy soldiers, electrical appliances and automotive parts . . . some on schedules as high as 100 loads per 24-hour day.

Low unit labor cost plus the new usefulness of scrap plastic make startling economies.

Stokes leads the vacuum metallizing field with units of 24, 36, 48 and 72-inch diameter, some operated by pushbutton control. Stokes Laboratory will metallize your samples, recommend techniques, plan cycles, report on overall costs, train your operators and otherwise share with you our 50 years of leadership in plastics and vacuum technology.

Write for a comprehensive brochure, "Vacuum Metallizing Today."

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STOKES

STOKES MAKES: High Vacuum Equipment, Vacuum Pumps and Gages / Industrial Tabletting, Powder Metal and Plastics Molding Presses / Pharmaceutical Equipment

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A model
for every range
of pyramid
testing

ACCO products

Wilson "Tukon" Micro Hardness Testers

Model LR—Floor model for Micro and Macro Hardness testing

Model FB—Floor model for Micro Hardness testing only

Model MO—Table Model for Micro Hardness testing only

These "Tukon" models meet every fine test requirement

• WILSON "TUKON" Micro Hardness Testers are unexcelled for testing metallic and non-metallic parts such as fine wire, small precision parts, thin metal, shallow superficially hardened surfaces, jewels, plastics, glass, etc.

The three models pictured cover the entire range of diamond pyramid testing—with both Knoop and 136 degree Diamond Pyramid Indentors.

Proper selection of the proper model for your particular requirement depends on the type and thickness of work to be tested, range of loads, purposes for which the machine is to be used—research or control, other hardness testing equipment available and whether a combination of micro and macro hardness testing is required.

We invite you to consult with WILSON engineers on your hardness testing problem. There is no obligation. Write for Booklet DH-114 on WILSON "TUKON" Micro Hardness Testers.

ACCO **Wilson Mechanical Instrument Division**
AMERICAN CHAIN & CABLE
230-E Park Avenue, New York 17, N. Y.

WILSON "ROCKWELL" and "TUKON" Hardness Testers

TRADE MARK

For more information, turn to Reader Service Card, Circle No. 446

New Materials, Parts, Finishes

handled easily. Exposed to 2000 F for 20 sec it extinguishes its flame in 30 sec and shows no significant change in length.

Silastic S-6526, a 50 durometer stock, is said to have a high degree of resistance to compression set, good handling qualities and flexibility at temperatures down to -130 F. Parts fabricated for low temperature service require only a short cure to attain optimum physical properties.

Heat-Sealing Material Produced in Powder Form

Half-second butyrate, a low viscosity cellulose acetate butyrate film former, is now being produced in powder form to simplify heat-sealing of any porous or semi-porous material. It is particularly effective in sealing paper, cloth and wood, and according to the manufacturer, there is some indication it may be used on aluminum foil. Conventional heat-sealing materials have been applied as solvent lacquers or hot melt compositions, depending on the application and facilities available. Though half-second butyrate compounds have been available in both these forms, the development of a powder form results in a greater

design with QUALITY felt in mind!

Gaskets, washers, wick lubricators are just a few applications of felt. Felt reduces vibration, controls noise, seals oil in, water out. American makes many types of felt, in rolls, sheets, and in parts cut to your blueprints, ready for assembly. Tell us what you make, or are designing, and we will send technical information along with our suggestions.

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FREE! *Catalog containing 47 samples of felts plus 24-page booklet of Wool Felt Standards. Write for Catalog 185-52.*

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ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

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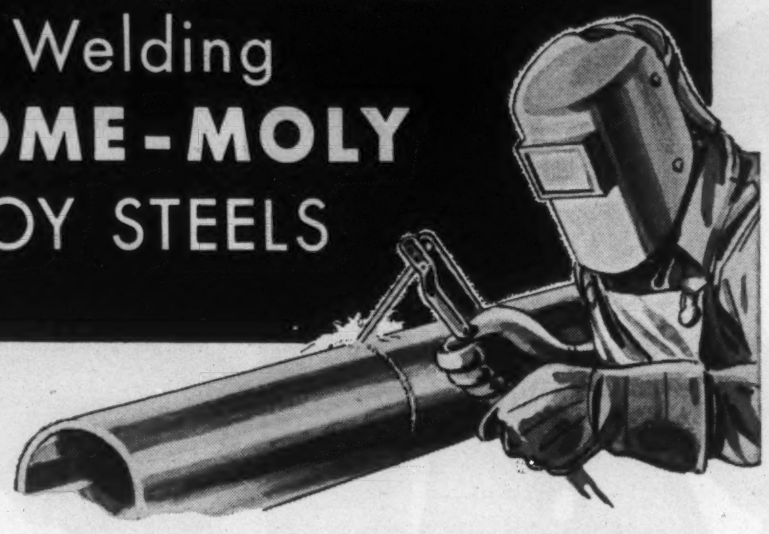


CHAMPION PIONEERS AGAIN —

in Making Available
NEW ELECTRODES
for Welding
CHROME-MOLY
ALLOY STEELS

Champion now brings to the fabricator of Chrome-Moly Steels a new type of low hydrogen electrode of the AWS xx15 type, excellent for all position welding.

Champion's Croloy Electrodes produce a weld deposit with a carefully controlled composition which almost completely eliminates weld cracking and greatly reduces the preheat necessary as well as relieving the necessity of maintenance of preheat prior to stress relieving.

Champion Croloy Electrodes produce very smooth weld deposits in all positions and pass the most rigid X-ray requirements. Weld deposits from Croloy Electrodes possess very high ductility, 20-26% in the as-welded condition, and 24-30% stress relieved at 1350°F, as well as show stress-to-rupture properties equal to or exceeding that of the plate material. Champion Croloy Electrodes 3/32" through 3/16" diameters are available in grades for welding .5% Cr, .5% Mo through 5% Cr, .5% Mo material.

Complete technical data on Champion Croloy Electrodes will be furnished upon your letterhead request. Write Now! Dept. M

THE CHAMPION RIVET COMPANY
CLEVELAND 5, OHIO EAST CHICAGO, INDIANA

For more information, turn to Reader Service Card, Circle No. 342

variety of possible methods of application.

Produced by *Eastman Chemical Products, Inc.*, 260 Madison Ave., New York, the powder is composed of 80% half-second butyrate and 20% triphenyl phosphate. In use, Eastman recommends operation of sealing machines at 40-60 psi at a temperature of 325 F. Blocking occurs at temperatures around 160 F at slight pressures. The material is specifically recommended for packaging applications.

Aluminum Alloy Cuts Fabrication, Welding Costs

A new aluminum alloy, designated 5083, has been developed for use in welded structures requiring maximum joint strength, efficiency plus light weight, and corrosion resistance. The alloy has good weldability using the semi-automatic process, according to the producer, *Kaiser Aluminum & Chemical Corp.*, 1924 Broadway, Oakland 12, Calif. It is available in "O" and H-113 temper plate ranging in gage from 0.250 to 2 in. and standard lengths in widths from 12 to 90 in.

The alloy is said to have higher strength, but slightly lower formability than alloy 5086, developed last year. Its tensile strength in the annealed condition is said to be appreciably higher than that of alloy 5052 and more than double that of 6061. Corrosion resistance is said to be comparable to that of 3003 and 6061. According to Kaiser, the nonheat-treatable alloy can be welded rapidly with inert-gas arc welds, producing joints with ultimate tensile strengths of around 42,500 psi. Joint efficiencies vary from 75 to 100% depending on temper of parent metal. The accompanying table lists typical physical properties of 5083 plate in both tempers.

Applications for the alloy are

WAITING ROOM

Rely on **TORRINGTON** for Volume Production of small precision parts

Volume production of small precision parts is a habit at Torrington. Each day we produce millions of pieces . . . exactly to customers' specifications of tolerance, hardness, temper and finish.

And we do it *faster, better and for less* than they can do it themselves. Send us a sample part or blueprint for a prompt quotation. And ask for our Condensed Catalog which shows hundreds of typical parts on which we can save you money.

THE TORRINGTON COMPANY
Specialties Division
777 Field Street, Torrington, Conn.

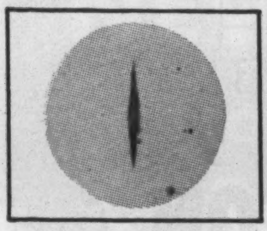
TORRINGTON *SPECIAL* **METAL PARTS**

Makers of Torrington Needle Bearings

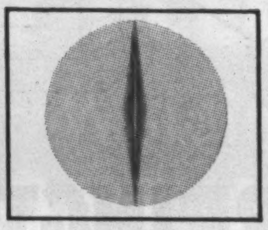
For more information, turn to Reader Service Card, Circle No. 328

A composition that is almost twice as hard as the hardest steel . . . KENNAMETAL*

Kennametal is the registered trademark of a series of hard alloys of tungsten, tungsten-titanium, and tantalum carbides. These compositions are the *hardest* practicable metals made by man. In scratch hardness tests, these hard carbide particles are between sapphire and diamond. On the Rockwell "A" Scale, different Kennametal grades test from 90.0 to 93.0, while that of HSS 18-4-1 heat-treated steel tests a maximum of 85.0. The Knoop Test gives 2100 (K100) for Kennametal and 800 (K100) for steel.



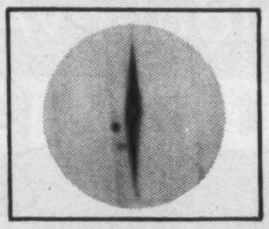
K8 Tungsten carbide



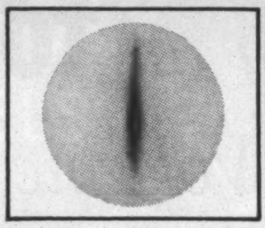
18-4-2 Steel

Photomicrographs above show results of Knoop hardness test on Kennametal K8 (left) and HSS 18-4-2 steel (right) at 100g. Impression in the Kennametal is only about half of that on the steel.

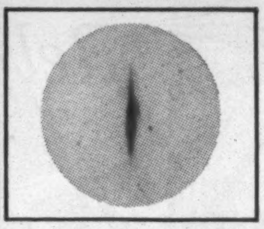
Photomicrographs below are of Knoop tests on grains of carbide ingredient of Kennametal. Knoop test numbers (at 100g) are: tungsten carbide, 1900; tungsten-titanium carbide, 2200; titanium carbide, 2500. These tests show those carbides are from two to three times as hard as steel in the absolute scale of Kgs per square mm of area of impression.



Tungsten carbide

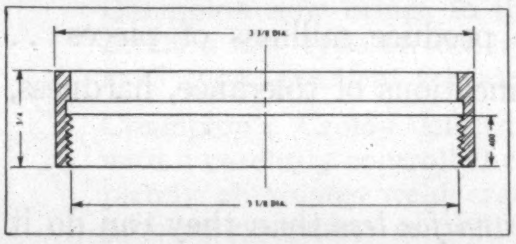


Tungsten-titanium carbide

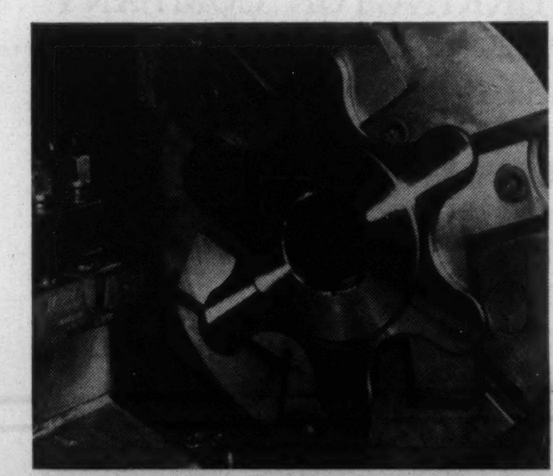


Titanium carbide

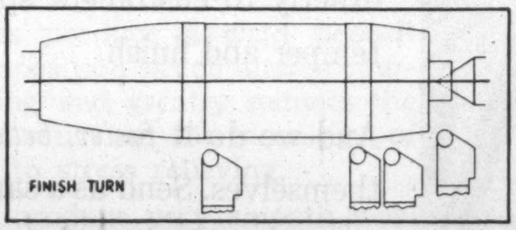
Extreme Hardness of KENNAMETAL Utilized by Designers



A West Coast manufacturer switched to solid Kennametal tungsten-titanium carbide tools for internal threading of stainless steel rings, jumped production from 35 to 40 pieces between grinds to 80 to 100 pieces with Kennametal. And the latter showed no cratering and only slight edge wear requiring only light grinding.



A manufacturer of aircraft landing gears uses the hardest grade of Kennametal cutting edges for interrupted cutting of SAE-4340 steel (220,000 psi tensile strength), at 1½ times greater speeds and with over 10 times longer tool life. Both sides of 54 pieces are rough cut and finish cut between grindings.



2400 to 3600 (depending on shell hardness) 90 mm shells are finished-turned using the hardest grade Kennametal before regrinding is required.

Perhaps KENNAMETAL's Extreme Hardness Can Help You, Too

Together with absolute hardness goes surprisingly greater resistance to wear and deformation. It is vital to innumerable industrial applications. Perhaps it is the characteristic you need to get YOUR idea off the drawing board and into production. It is worth investigating. Write to KENNAMETAL INC., Latrobe, Pennsylvania, and ask for Booklet B-111.

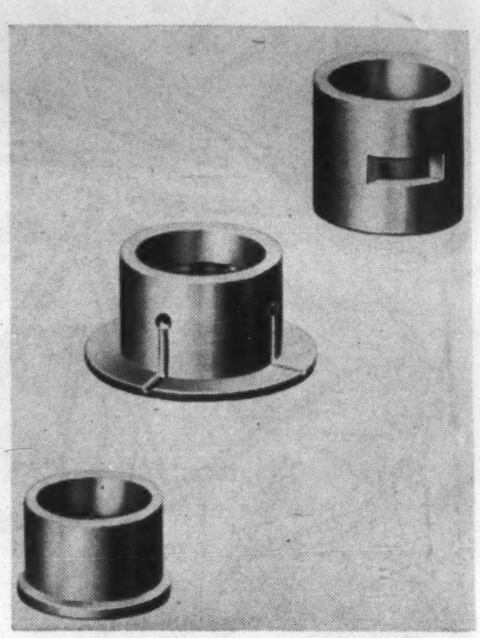
*Registered Trademark

7250

INDUSTRY AND
KENNAMETAL
...Partners in Progress

For more information, turn to Reader Service Card, Circle No. 463

expected to include marine decks, hatch covers, masts, bulkheads, superstructures and hulls; automotive frames, dump truck bodies, fifth wheel assemblies, landing gear and tractor bodies; structural towers for TV, electrical transmission, gin poles, mobile cranes, elevated water tanks, etc.



Bearing Alloy Has Corrosion Resistance, Good Appearance

A new silvery white bearing alloy, said to have good anti-friction characteristics and high resistance to corrosion has been developed by *Bunting Brass & Bronze Co.,* 715 Spencer St., Toledo, Ohio. Designated Bunting No. 183, the alloy has the following composition: 63-67 copper, 3.5-4.5 tin, 3-5 lead, 6-10 zinc, 19.5-21.5% nickel. The alloy was developed specifically to combine mechanical properties with pleasing appearance in sanitary food processing machinery. It has a tensile strength of 30,000 psi, yield strength of 17,000 psi, elongation in 2 in. of 8%, and a Brinell hardness of 95 with 500 kg and 109 with 1000 kg. According to the manufacturer, the alloy offers a high degree of resistance to food acids and compounds.

(More New Materials on p. 168)

CORNING GLASS BULLETIN

FOR PRODUCT DESIGNERS

Ingredients for light that's absolutely right . . .

Light that really meets the needs of surgeons must be glareless, shadowless, cool and color balanced.

That's the kind they get from the Wilmot Castle Company's surgical lights. Glare and shadows are disposed of by an ingenious metal reflector of Castle design.

Cooling and color balance are handled by a *special* glass we make—for use in Castle lights. Called AKLO, it blocks infrared waves emanating from an artificial light source by converting the infrared into molecular heat.

A piece of AKLO 4 mm. thick absorbs some 87% of the infrared waves. Result—after an hour of continuous exposure, for every 1,000 foot-candles of illumination, a thermometer 20 inches from the light source shows a rise of less than 3° F.

Light from AKLO is the right *hue*, too, since it eliminates the greenish cast normally associated with heat-filtering glasses. And, this light is as close to natural as it's possible to obtain from artificial sources. That's a vital point in proper diagnosing of pathology, and in observing a patient's coloring.

AKLO's light is also balanced in terms of temperature. It runs to about 4,000° K., just right for shooting accurately rendered color movies and telecasting operations in color.

AKLO is one example of Corning's several successful conquests of problems involving energy control.

Experience suggests that there's more than just an outside chance that any pressing energy control problem you may have can be effectively (and economically) coped with by a glass we already make.

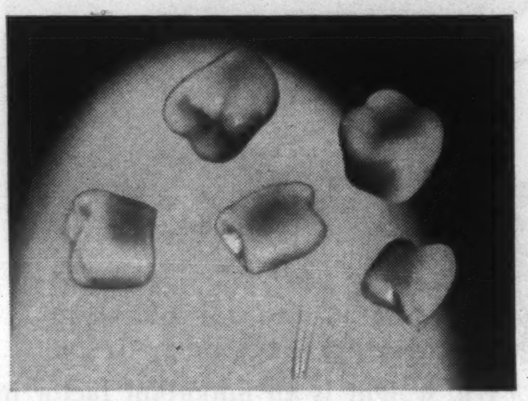
If you want to find out, drop us a note about your problem wave. We'll peer into our files and let you know *which* glass, if any, can do the job.

Denture adventure

A dental chap, we learn, is experimenting with glass for artificial teeth.

He's molding them from a mixture that's mainly ground-up VYCOR brand glass. Reason? Ordinary enamels don't stand up very well under the high heat needed to set the teeth in rubber. VYCOR brand glasses do. Result? Savings in breakage, annoyance, and time.

VYCOR brand glasses come in seven different forms. Basic characteristic of all is a very high percentage of silica—96%. It's the silica which makes the VYCOR brand glasses almost immune to temperatures up to 900° C. (higher under certain operating conditions) and endows them with unusual resistance to thermal shock.



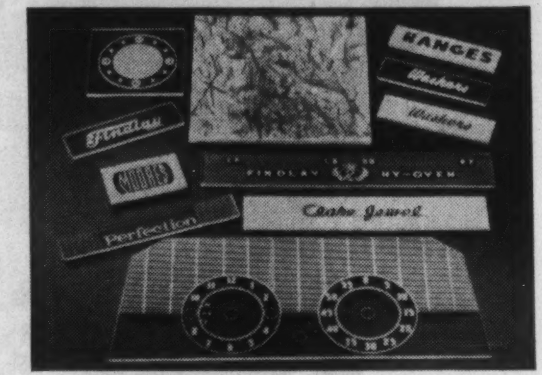
The thermal properties of the VYCOR brand glasses make them useful in such products as calcining jars, thermocouple protector tubes, sight glasses for high heat furnaces. And ability to handle ultraviolet and infrared rays make them favored contenders for use in germicidal lamps, sun lamps, photochemical lamps and the like.

This is a far cry from our starting point on dentures, but, it may help you to see that the VYCOR brand glasses are both versatile and quite remarkable.

Bulletin B-91 details types, physical characteristics, and present uses of these glasses. Your name in the coupon will bring the literature to your desk.

Print it in glass!

These pictures tell the story much better than words.



Designs, name plate, dial face—they're all printed in glass. Not *on* glass, but *in* it!

The glass is called *Photolay*. One of the things that intrigues most people who see a picture printed *in* Photolay is its three-dimensional effect. It has depth. The image seems to float in the glass with all the attributes of reality. Even lettering, or a line drawing, acquires a special sort of difference.

Besides, an image in Photolay is permanent. It won't ever fade, get scratched off, or tarnish.

Photolay is one of several photosensitive glasses developed by Corning. They all have this in common: When exposed to ultraviolet light through a negative, a latent image forms right in the glass. Heat treatment develops this image.

What's it good for? Maybe *you* have some ideas a photosensitive glass might give a special twist to. So far, stove and appliance manufacturers have put it to use in name plates, escutcheons, dials and such. If your problems are similar, let us know.

If the items discussed here seem unrelated to your immediate interests, we still may have what you need at our fingertips. We'd count it a pleasure to hear from you.

Corning means research in Glass

CORNING GLASS WORKS

12-6 Crystal Street, Corning, N. Y.

Please send me Bulletin B-91 on the VYCOR brand glasses.

Name____________________ Title__________

Company______________________________

Address______________________________

City________________ Zone______ State__________

For more information, turn to Reader Service Card, Circle No. 449

Keep Your Weight Down

Yes, weight is an important factor in selecting the right castings.

Well-Cast *lightweight* castings, aluminum or magnesium, have been an asset to many production operations for almost half a century. Their high strength, easy machinability, good surface finish and extreme lightness reduce human fatigue and decrease operating costs.

Don't delay . . . call or write us right now. We'll be glad to help you select the Well-Cast casting for your needs.

Catalog No. 53 on request.

Well-Cast MAGNESIUM, ALUMINUM AND BRONZE CASTINGS

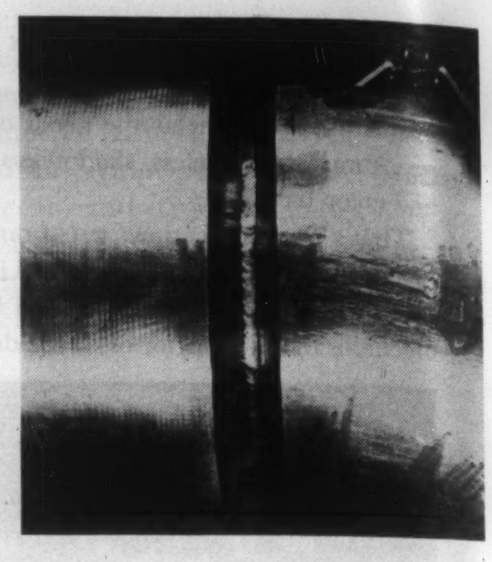
Well-Made WOOD AND METAL PATTERNS

THE **WELLMAN** BRONZE & ALUMINUM CO.

Dept. 30, 12800 Shaker Boulevard Cleveland 20, Ohio

For more information, turn to Reader Service Card, Circle No. 359

New Materials, Parts, Finishes



New Process Aids Root Welding

A new welding process called K-Weld is said to provide close control over the application of root beads to hard-to-weld materials such as titanium, superalloys, aluminum and air-hardening steels. The process, developed by the *M. W. Kellogg Co.,* P.O. Box 469, Jersey City, N.J., uses inert gas shielding and employs an interior gas chamber fixture, permitting accurate control of gas pressure inside a pipe or similar type of weldment. By varying gas pressure, the inner bead surface can be made slightly convex, flush or even concave.

According to the manufacturers, control of weld penetration is inherent in the process. Through precise control of technique, physical dimension and internal gas shielding pressure, the process is said to produce root beads with full penetration, controlled internal contour, uniform surface free of undercutting, and with a high degree of bead reinforcement. This is accomplished without backing rings and with only average operator proficiency.

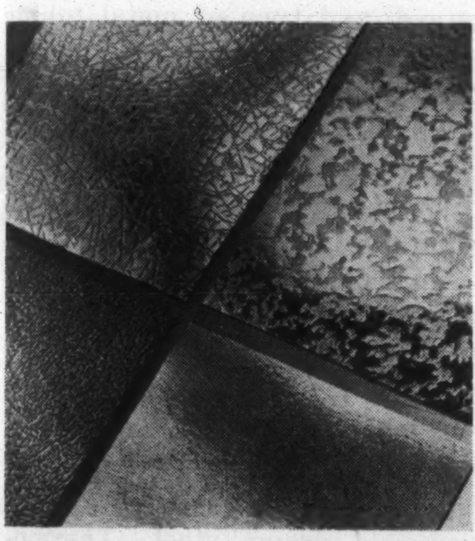
Encapsulating Resin Is Self-Extinguishing

A new epoxy casting resin for encapsulating and embedding electrical components is said to be self-extinguishing when tested by standard ASTM procedure. Ac-

For more information, Circle No. 301 ➤

cording to the manufacturers, *Aries Laboratories, Inc.*, 270 Park Ave., New York 17, test embedments showed fire resistance superior to other commercially available epoxy resins.

Designated Aritemp 316, the material is said to have a high heat distortion point and good low temperature properties. To demonstrate good thermal shock characteristics, a casting containing steel test pieces was subjected to repeated cycling between -75 and 300 F, with no resultant cracking.



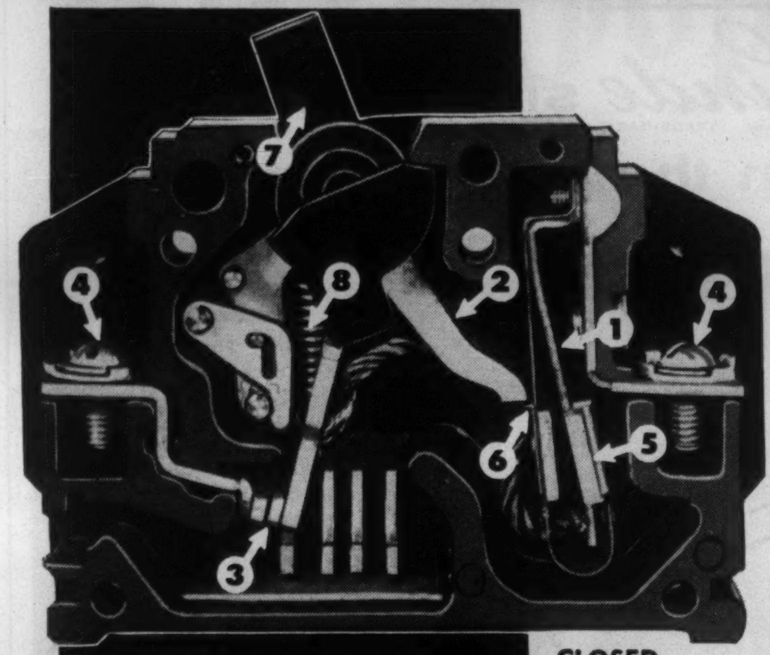
Patterned Steel Provides Decorative Effect

A pattern-designed cold rolled strip steel is being produced by *Thomas Strip Div., Pittsburgh Steel Co.*, Warren, Ohio. It can be supplied in plain steel or electrolytically coated with copper, brass, nickel, chromium, zinc or lead alloy in natural, planished or buffed finishes. It can be hot-dip coated with lead or tin, and coated with either clear or colored lacquer. Intended primarily for decorative applications, the material is being produced in widths up to 18 in. and in thicknesses from 0.010 to 0.125 in., depending on pattern, type of coating and finish.

(*More New Materials on p. 172*)

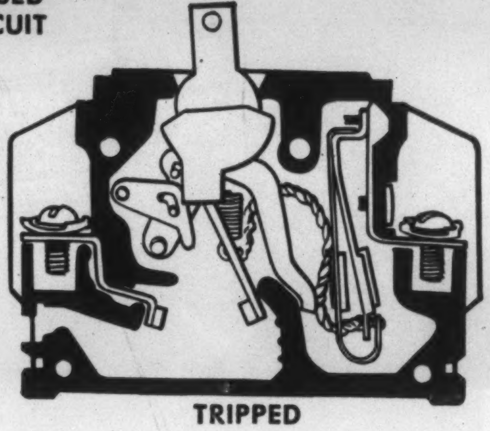
HOW CHACE THERMOSTATIC BIMETAL ACTUATES THE I-T-E CIRCUIT BREAKER

PRODUCT OF
I-T-E CIRCUIT BREAKER CO.,
PHILADELPHIA, PENNSYLVANIA

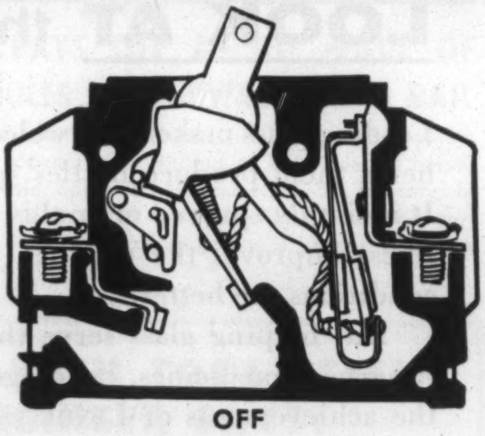


CLOSED CIRCUIT

NOMENCLATURE
1 BIMETALLIC ELEMENT
2 LATCHING ARM
3 CONTACTS
4 TERMINAL
5 INSTANTANEOUS MAGNETIC TRIP
6 LATCH TRIP
7 MANUAL OPERATING HANDLE
8 SPRING



TRIPPED



OFF

I-T-E type EQ breakers are designed for use in panelboards and load centers or for individual mounting where the voltage does not exceed 120 volts a-c to ground. It combines thermal-magnetic tripping action to afford complete protection against both small overloads and short circuit faults. Arc chutes, silver alloy contacts and a quick make-and-break trip-free mechanism combine to make this a premium grade breaker. It is furnished in either one or two pole designs.

HOW IT OPERATES

An element of Chace Thermostatic Bimetal furnishes the actuating medium for breaking the circuit under conditions of small, gradual overload. The bimetal strip (1) is carefully and accurately calibrated to deflect at a predetermined temperature range. Its deflection directly actuates the tripping mechanism of the circuit breaker by releasing the spring-loaded latching arm at (2) causing the contact rocker to break the circuit instantly at contacts (3) in response to the same spring tension. **Chace Thermostatic Bimetal is available in 29 different types, in strip, coils or in complete elements fabricated to customer specifications. Send for our new, free 36-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing valuable engineering information for designers of thermally responsive devices.**

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

For more information, turn to Reader Service Card, Circle No. 393

LOOK HOW Linde TRADE-MARK silicones brighten the glass picture

Glass bottles! The average American uses 118 a year. That's 18 billion in all. More and more are being made faster, tougher, and better, at less cost, with the help of LINDE Silicones.

LOOK AT the reasons why

Leading glass makers are welcoming a type of LINDE Silicone that helps them produce bottles sparkling clean—with fewer rejects. It is simply sprayed on molds, shear blades, and chutes. Its cleanliness improves the product. With no soot and smoke, working conditions are better.

But helping glass serve the tremendous business of bottling America's medicines, beverages, cosmetics, foods, is only one of the achievements of LINDE silicones. Many other industries are taking advantage of the "slipperiness," the strong resistance to heat and cold, the water repellency, and other useful qualities of this versatile family of chemicals.

Because LINDE and other divisions of UNION CARBIDE serve customers in so many fields, LINDE is particularly qualified to supply and help you use silicones that can improve your products or processes, and reduce their costs. Write Dept. N-6.

LOOK TO Linde for silicones

Linde AIR PRODUCTS COMPANY | A DIVISION OF UNION CARBIDE AND CARBON CORPORATION

30 East 42nd Street, New York 17, N. Y.

In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited
The term "LINDE" is a registered trade-mark of Union Carbide and Carbon Corporation.

For more information, turn to Reader Service Card, Circle No. 391

New Materials, Parts, Finishes

Ceramic Insulated Thermocouple Wire

Thermocouple and thermocouple extension wires, insulated with ceramic, and protected from mechanical damage by various types of seamless metal tubing, are being marketed under the trade name Ceramo by *Thermo Electric Co., Inc.,* Saddle River Township, Rochelle Park Post Office, N. J. Diameters range from 1/25 to ¼-in. o.d. The wires are made in lengths up to 30 ft while the extension wires vary in length up to 2000 ft, depending on o.d. and type of metal tubing used. All conform to standard ISA calibration accuracies. Thermocouple wires are made in iron-Constantan, Chromel-Alumel, copper-Constantan, Chromel-Constantan, and platinum-rhodium platinum. The seamless tubing is of stainless steel, Inconel, aluminum or copper. Extension wires are made of iron-Constantan, Chromel-Alumel, or copper-Constantan. The extension wire tubing is of copper-nickel, or plain or galvanized cold drawn steel. Thermocouple extensions are produced in ⅛ and ¼ in. o.d.

Corrosion Resistant Resin-Base Paint

A thermoplastic resin-base paint containing an inhibitor for rust and corrosion resistance has been developed which is priced competitively with ordinary house paint. Called Corro-Vent, it can be applied by brush, spray, dip or flow-coat processes and dried either by air drying in 30 min or by baking at temperatures from 150-300 F. Although the resultant finish is hard and glossy, it remains ductile and does not chip, crack or peel, according to the manufacturer, *Corro-Vent, Inc.,* 510 Mercantile Library Bldg., Cincinnati 2, Ohio.

The coating is said to be resistant to acids, alkalis, alcohol,

Tool Steel Topics

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

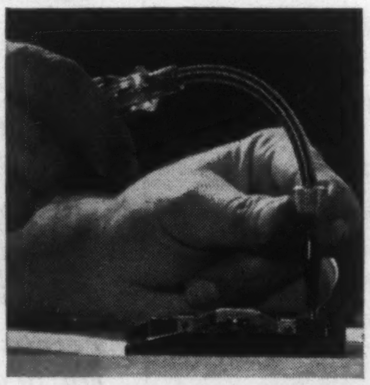
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributors Bethlehem Steel Export Corporation

They Wing Screw Drivers at Fast Clip with Dies of BTR

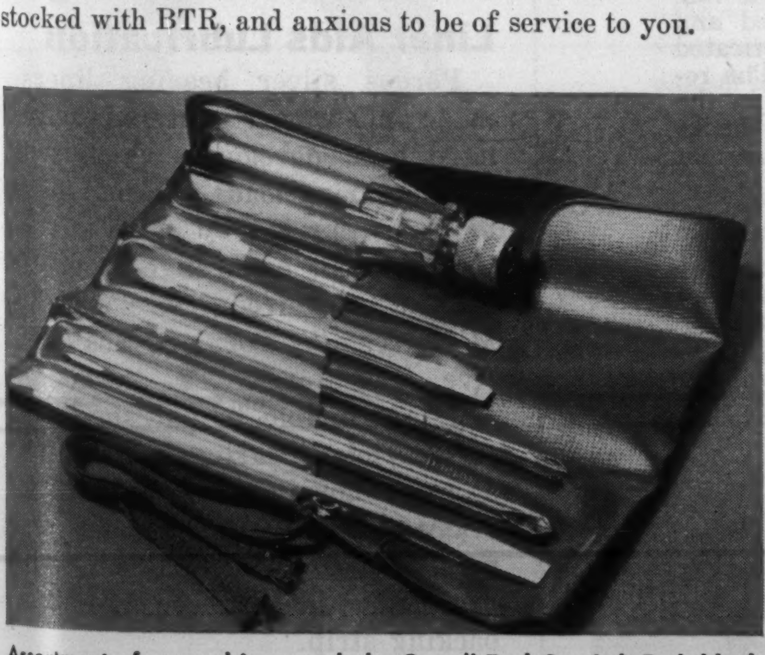
It's efficiency-plus at the busy plant of Oxwall Tool Co., Ltd., Oxford, N. J. For here there's every kind of machine for the high-speed manufacture of all kinds of quality screw drivers. They turn them out by the millions, large and small, including an ingenious worm-like screw driver which can be bent around corners at the touch of a finger.

The plant has a battery of 10-ton presses where the wire blank is winged on the end opposite the blade (see illustration above) so that it can be anchored in the plastic handle. The typical forming dies used in this operation are made of BTR (Bethlehem Tool Room) tool steel. Oxwall engineers tell us that these BTR dies, hardened to Rockwell C48-50, are giving long service life in this application.



BTR is our general-purpose, manganese-chromium-tungsten grade of oil-hardening tool steel, perhaps best known for its safe hardening property. It also has good abrasion-resistance and toughness, and is ideal for practically every application where long wear is desirable.

If you would like to give BTR a workout in your shop just put in a phone call to your Bethlehem tool steel distributor. You'll find him well stocked with BTR, and anxious to be of service to you.



Assortment of screw drivers made by Oxwall Tool Co., Ltd. Each blank is winged by a die of BTR tool steel, for firm anchorage in handle. Model shown in illustration at the upper right, with flexible shaft which can be bent as needed, is an ideal time-saver for cramped quarters.

SHOCK-RESISTANCE PAYS OFF AS DIE MADE OF 67 CHISEL PUNCHES HOLES IN HIGHWAY GUARD RAIL

Because of its excellent shock-resisting properties, this die of Bethlehem 67 Chisel tool steel provides economical punching of bolt holes in beam-type highway guard rail. The die, hardened to Rockwell C-51, operates in a 200-ton press. In addition to its shock-resistance, 67 Chisel is wear-resistant, making it ideal for such applications as shear blades, hot-work tools, blanking tools and swaging dies.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Here's How to Harden Tools with Holes

Ordinarily holes in tools cannot be eliminated. Nor can their size or location be changed, in most instances. So steps must be taken to control the ill effects of holes, such as tools cracking during the hardening operation. Although it is impossible to outline a procedure for all tools, the following principles are recommended for those containing holes:

1. Quench tools so that the internal surfaces of the tools harden completely. When holes are relatively large, no special attention may be necessary; for small holes, flush-quenching may be required.

2. If it is possible that effective quenching may not occur completely throughout the holes, pack them so that hardening cannot take place in the holes, assuming that this condition is allowed on the tool. Use clay, asbestos, steel wool or steel inserts.

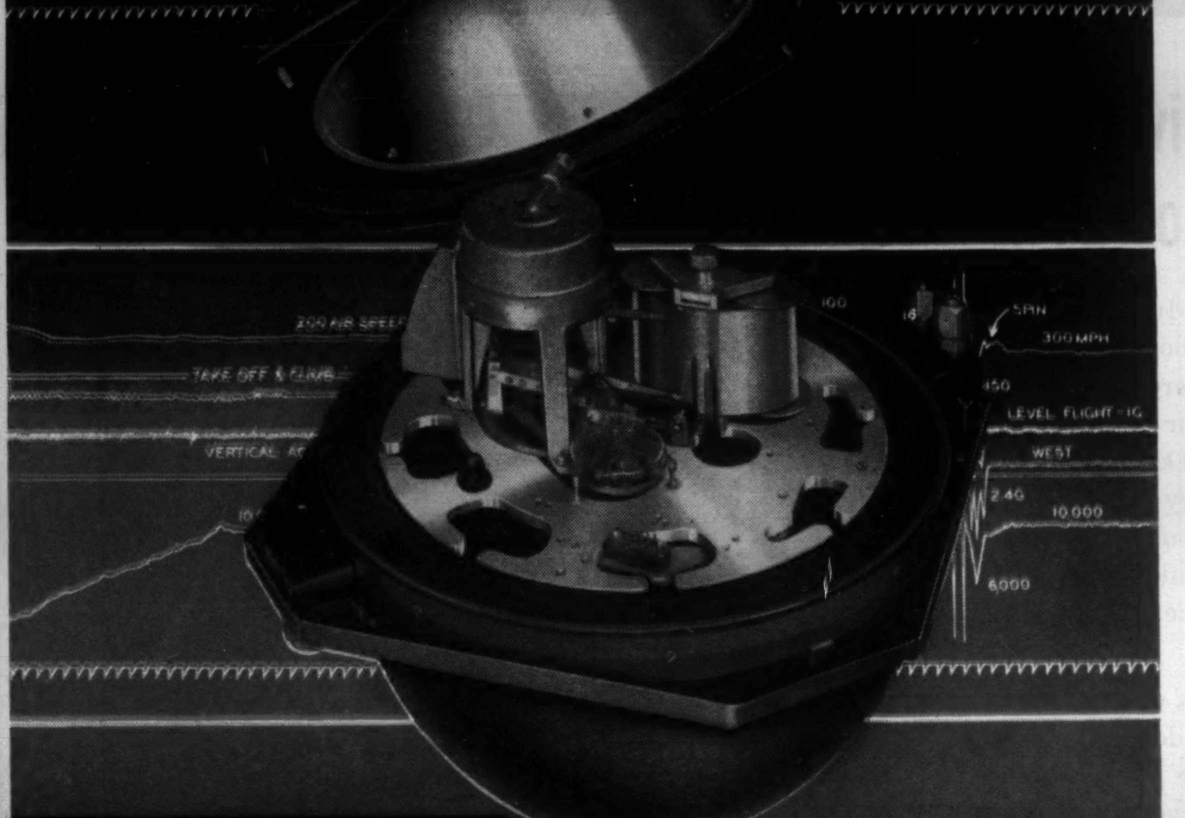
3. If only the surface of a hole is to be hard, as on a ring die, flush-quench the bore while protecting the outside surface from the quench.

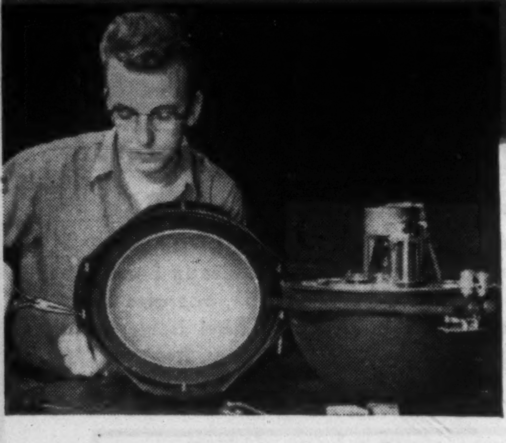
The internal surface of a hole should be either uniformly hard, or uniformly soft. The worst possible condition is an irregular hardness pattern on the inside surface, because the high stress developed may result in cracking.

For more information, turn to Reader Service Card, Circle No. 425

Spincraft did it for General Mills

Spincraft can do it for you!

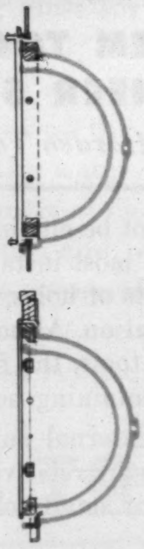




Spun spheres protect mechanical fingers of world's toughest recorder

another example of Spincraft's "start-to-finish" fabrication

15 Different Operations — The sphere, protecting the delicate sensing instruments, is completely fabricated by Spincraft. The sphere consists of an outer steel and inner aluminum shell separated by insulating material. The two hemispheres are joined together by an ingenious locking and sealing arrangement. Spincraft's complete fabricating responsibility involved spinning, machining, arc-welding, spot welding, brazing, grinding, sawing, drilling, braking, stamping, phosphate plating, anodizing, painting, assembly and pressure testing. Craftsman (above) is shown assembling a Flight Recorder.



This aircraft Flight Recorder, manufactured by the Mechanical Division of General Mills, etches a continuous 300-hour record of heading, air speed, vertical acceleration and altitude on aluminum foil. Each Recorder is fully-enclosed and protected in a specially fabricated sphere — made by Spincraft. The recording device, when enclosed in the sphere, is designed to withstand shocks of 100G's and resist temperatures of 2000°F up to 30 minutes.

This is another example of Spincraft's versatility and manufacturing skill. We offer complete facilities for contract manufacture of finished parts, assemblies and complete products.

Take advantage of our modern tools for spinning, deep drawing and stamping as well as complete fabrication. They can pay off in savings for you.

Write for Spincraft data book. If you have a specific problem, tell us about it — no obligation.

The Spincraft Manual

WORKSHOP OF AMERICAN INDUSTRY SINCE 1919

World's largest plant fully equipped for all types of metal spinning • deep drawing • stamping • fabricating

Spincraft
SKILL WILL DO IT
INCORPORATED

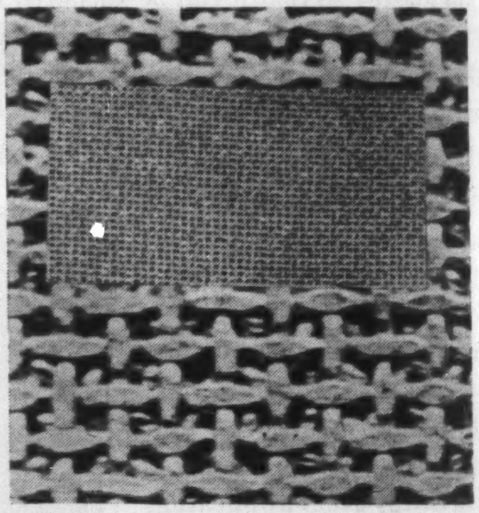
see our catalog in S or write for copy

4134 WEST STATE STREET • MILWAUKEE 8, WISCONSIN

New Materials, Parts, Finishes

water, salt water, grease, vegetable and mineral oils. It will not mildew, oxidize or saponify. It is non-conductive, non-skimming and can be stored indefinitely. One coat is said to be sufficient to cover a surface, except where extreme inhibitor efficiency is needed, in which cases two coats are recommended. Other paints may be applied over the base without impairing the protective surface.

Available in a variety of high gloss colors, Corro-Vent is recommended for use on structural metals in manufacturing, refineries, utilities, automotive applications and in agriculture.



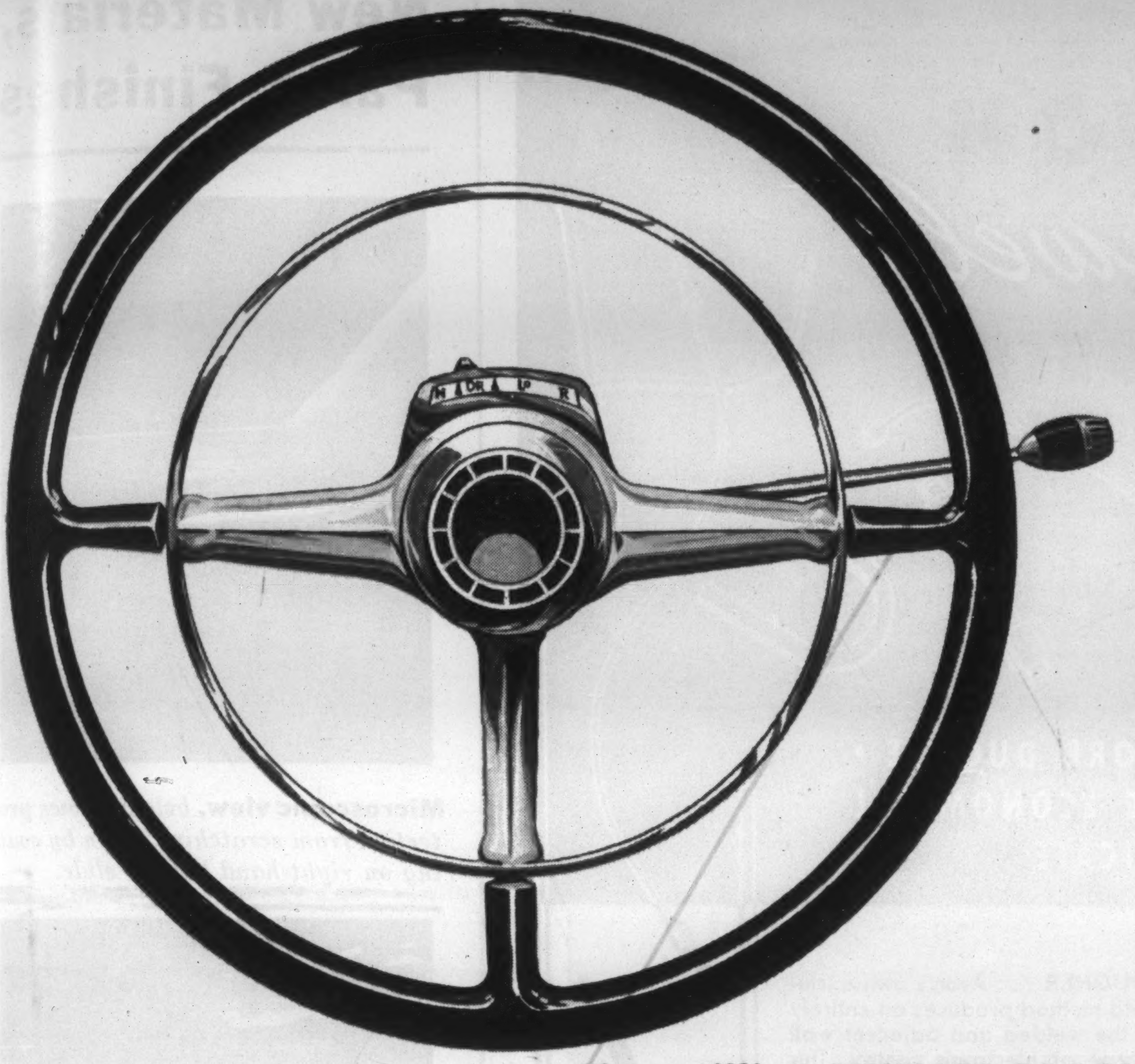
***Porous liner** shown here is magnified 10 diameters. Inset is actual size.*

Porous Silver Bearing Liner Aids Lubrication

Porous silver bearing liners, made of woven sintered wire, have been developed which will carry bearing loads of 50 to 75% of those carried by solid silver. Void content can range from 10 to 50% as desired. Developed by *Micro Metallic Corp.*, 30 Sea Cliff Ave., Glen Cove, N. Y., the material is available in flat sheet, or as completed bearings, fitted into a steel housing. According to Micro Metallic, if sufficient demand appears, the material will become available brazed to a steel backing strip.

(More New Materials on p. 176)

◄ For more information, Circle No. 442



How a shift in gears saved $256,000

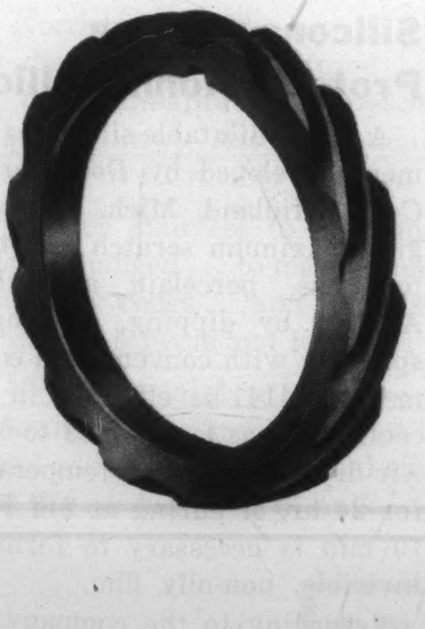
Five million MUELLER BRASS CO. forged ring gears improve automatic transmission operation . . . at lower cost to the manufacturer.

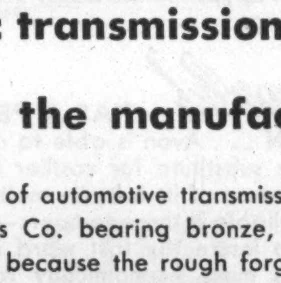
Ever since one of the leading manufacturers of automotive transmissions began using ring gears forged from Mueller Brass Co. bearing bronze, production costs have been cut nearly $256,000. That's because the rough forging weighs less and is closer to finished size than a sand cast ring gear formerly used. This shift in gears resulted in a savings in metal costs, greatly reduced machining time and increased tool life. In addition, the use of forged gears has cut scrap loss and eliminated costly inspection rejects.

The performance of these forged ring gears is also far superior to the sand cast gear, which had a tendency to flake away and crack around the teeth, causing failures. More than five million forged ring gears have now been used in these transmissions without a single failure. Being porous, the sand casting was difficult to balance, but the forging has a dense, homogeneous structure that helps keep it in perfect balance.

Strong, long-wearing non-ferrous metal parts, forged to your specifications by Mueller Brass Co., can help reduce your costs and improve the performance of your products just as they have done in this transmission application. For complete information, write us today.

Write today for your complete set of Mueller Brass Co. engineering manuals.





MUELLER BRASS CO. PORT HURON 16, MICHIGAN

154

For more information, turn to Reader Service Card, Circle No. 396

AVON
Fusionweld
STEEL TUBING

IT'S TOUGHER • MORE DUCTILE • SMOOTHER • MORE ECONOMICAL TO FABRICATE

Fusionweld IS TOUGHER . . . Avon's own exclusive high frequency resistance welding method produces an entirely new uniformity of grain structure in the welded and adjacent wall area by means of an advanced type of electronic control. This exclusive process combined with our improved cold drawing of larger size tubing into smaller diameters is responsible for the extremely smooth surface finish, closer diameter tolerances and new ease of fabricating.

Fusionweld HAS A PERFECTED SINGLE WALL CONSTRUCTION . . . Avon is able to offer thin wall tubing as a highly impressive substitute for costlier tubing—both ferrous and non-ferrous—because of its hi-cycle method of controlled welding. This tubing is available in three tempers—"as welded," "as drawn" and annealed to insure the last word in adaptability to varied tubing uses. It is more economically fabricated—takes tougher bends, beads, flares, etc.—withstands pressures up to 18,000 PSI—has no equal in resisting the severest types of fatigue from vibration.

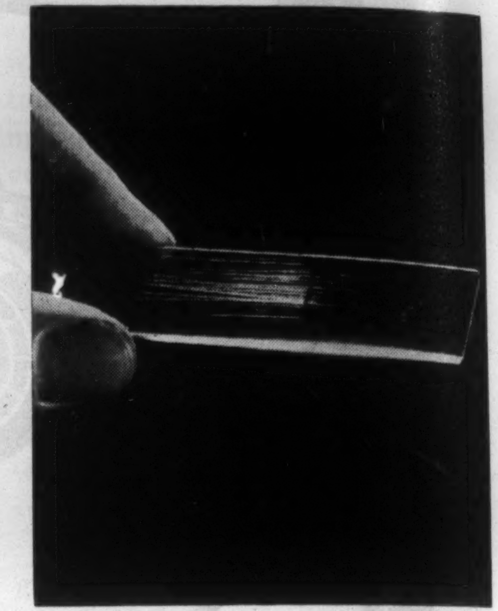
Fusionweld IS EASIER TO FABRICATE . . . Avon's exclusive tube making process has proved itself, matching the most difficult forming operations, with a higher degree of ductility and tensile strength to insure new fabricating ease, lower scrap loss, greater performance reliability. Today our mills are successfully producing over 7½ million feet per month for hundreds of important tubing applications. Our sales engineering staff will gladly assist you . . . or send us your blue prints for tube quotations.

3/16" O.D. to 3/4" O.D.
PLAIN OR TERNE COATED

AVON TUBE DIVISION
HIGBIE MANUFACTURING CO.
ROCHESTER MICHIGAN

For more information, turn to Reader Service Card, Circle No. 343

New Materials, Parts, Finishes

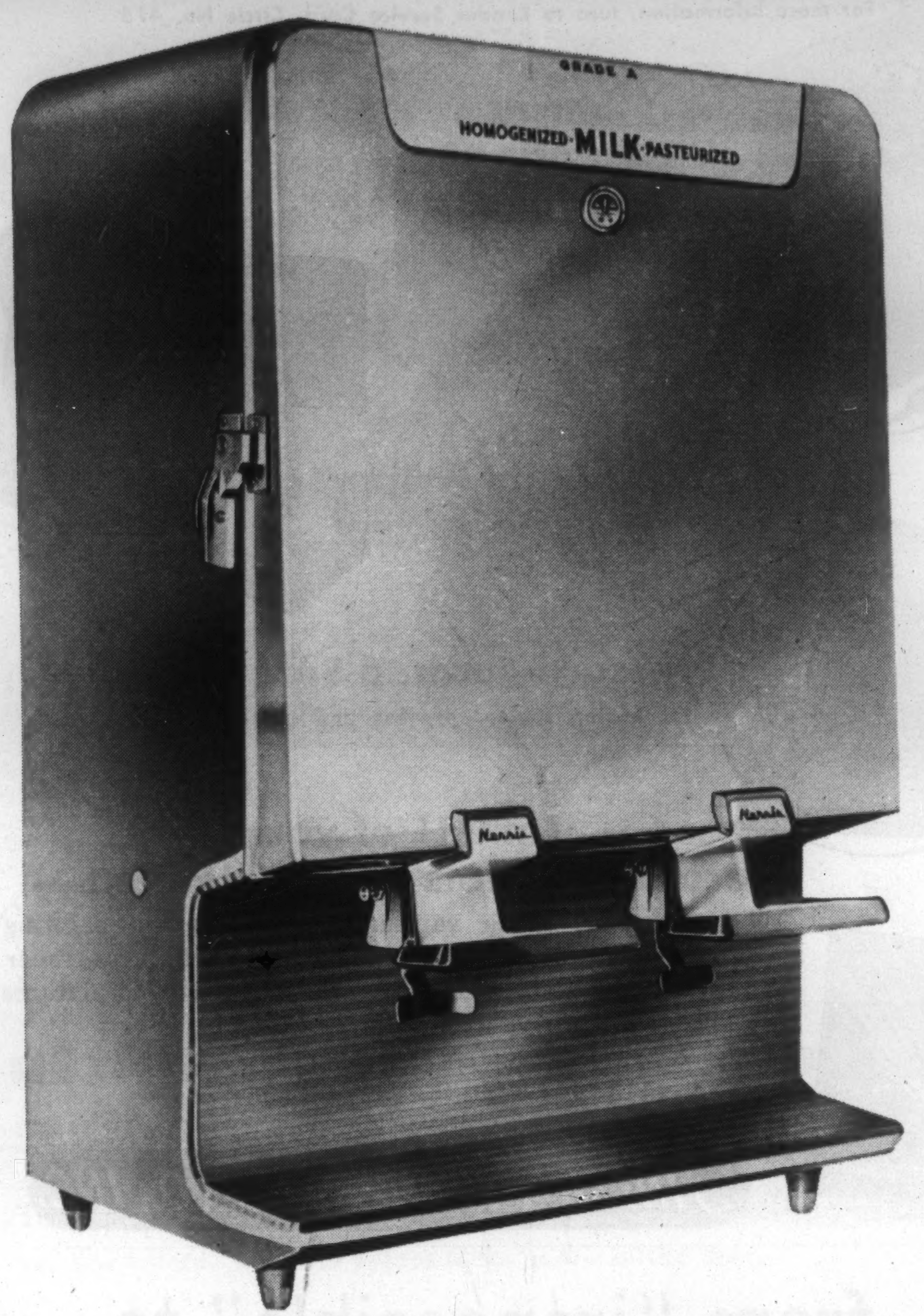


Microscopic view, *below, shows protection from scratching given by coating on right-hand half of slide.*

Silicone Coating Protects Nonmetallics

A water-dilutable silicone treatment developed by *Dow Corning Corp.*, Midland, Mich. is said to give maximum scratch resistance to glass, porcelain and china. Applied by dipping, flooding or spraying with conventional equipment, F-4141 is effective in concentrations as low as 0.01 to 0.1%. Air-drying at room temperature for 24 hr, or curing at 212 F for 10 min is necessary to form the invisible, non-oily film.

According to the company, the cured film is not affected by 2-hr exposure to live steam, perchlorethylene, or 3% sodium hydroxide. Although highly water repellent,



this attractive new dispenser of STAINLESS STEEL

meets every standard for cleanliness and top design

The Norristocrat is the newest addition to the line of milk dispensers manufactured by Norris Dispensers, Inc., of Minneapolis, Minnesota. It's designed by Raymond Loewy Associates and, like many Norris dispensers, it's Crucible stainless steel *inside and out.*

INSIDE, it's stainless to keep milk dairy-fresh, with flavor unchanged . . . to make cleaning easier . . . to meet all sanitary codes . . . and to satisfy the most exacting demands of schools and hospitals across the nation.

OUTSIDE, it's stainless to insure an attractive, lasting appearance that complements its clean, modern design . . . and adds to its promotional effectiveness for encouraging the consumption of milk.

Cleanability, product protection and bright good looks are the main reasons Norris insists on stainless steel. But stainless offers many other properties, too — among them corrosion and heat resistance, high tensile strength, excellent workability. And you'll find exactly the combination and degree of these properties you need in one of the thirty grades of Crucible stainless steel. To see what general and technical literature is available to help you make the most of Crucible stainless — or any other Crucible special purpose steel — write for your free copy of the Crucible Publication Catalog. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

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For more information, turn to Reader Service Card, Circle No. 475

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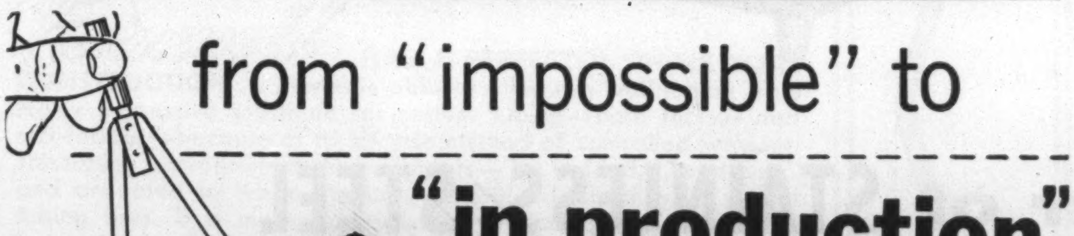

from "impossible" to "in production" with **GRC** die cast **tiny parts**

The unusual flexibility of Gries' die casting technique may answer your small parts problems. With almost unlimited design latitude, your designs—whether simple or complex—can be made exactly to your specifications, swiftly, accurately, economically. Cast in zinc alloy, in one automatic operation, completely trimmed! Let Gries' engineers solve your "impossible" problems.

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New Materials, Parts, Finishes

treated surfaces may be labeled with many resin-type inks and certain adhesives. Supplied from a 20% solution in tertiary butanol, F-4141 is said to be a stable solution with a long shelf life. Stability of solutions diluted with hard or soft water may be maintained for as long as 72 hr, the company says.

Plastics Soluble in Water Only

Two styrene resin modifications have been developed which are soluble in water but insoluble in practically all organic solvents. Presently available for evaluation, the resins are suggested for use as tackifiers, dispersants, thickeners and flocculants in a variety of aqueous systems. They are particularly recommended for use in water-based adhesive and paper-coating formulations. Called Lustrex 710 and 770, the resins are water soluble, even in the presence of large cation concentrations, according to the producer, *Monsanto Chemical Co.*, Springfield 2, Mass. Solutions show no appreciable changes in viscosity in a pH range of 1-12.

Lustrex 710 and 770 are derived from styrene polymers having molecular weights of 10,000 and 70,000 respectively. They are supplied as water-soluble sodium salts in the form of free-flowing powders. Solutions of the resins exhibit high initial tack which makes them useful in compounding adhesives. Lustrex 710 provides the higher initial tack because it provides solutions with higher solids content. Based on total compound solids, a resin concentration of 1-10% is said to be adequate. Lustrex 770 may be plasticized with certain polyhydric compounds to produce a satisfactory rewettable adhesive. When used in paper coatings, the resins are said to increase solvent, wet-rub, heat and flame resistance and adhesion.

(More New Materials on p. 180)

the difference is more than just a fine line

you can SELL the difference

There are few more commonplace products than a fountain pen... yet few where "hidden" values mean more to the user.

This, in fact, is typical of many competitive mass-production industries that depend upon an *extra* measure of control in the quality and uniformity of materials. Such industries are among the most enthusiastic boosters of the important difference to be found in Scovill Brass and Aluminum Mill Products . . . the way our customers can *depend* on the uniformity of metal specified . . . from lot to lot, from order to order.

More than 150 years of metal craftsmanship is part of the reason. Scovill's forward-looking commercial application of new methods, such as Continuous Casting and constantly active metals research programs, are part of it too. The net result is better metal delivered to your production line . . . uniformly conforming to your specifications . . . *different* in many important ways that help you fabricate and sell better products.

Scovill Manufacturing Company, Mill Products Division,
99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

SCOVILL **MILL PRODUCTS**

BRASS • BRONZE • NICKEL SILVER • ALUMINUM

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ANNEALING ALUMINUM STRIP IN CONTROLLED ATMOSPHERE

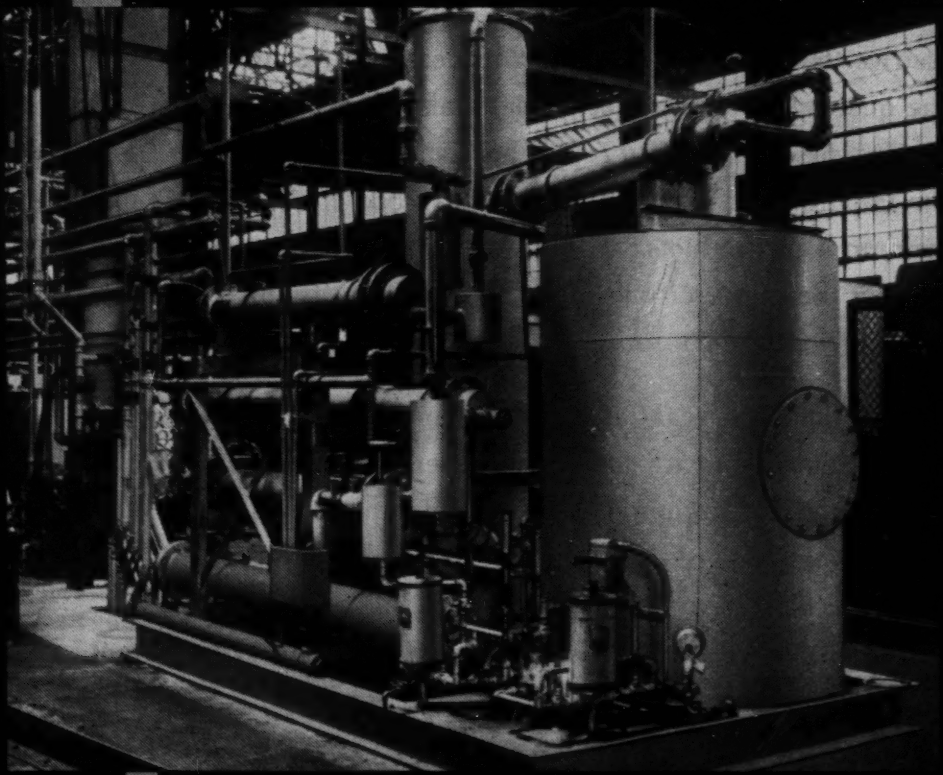
Scovill Manufacturing Co. Selects GAS ATMOSPHERES' GENERATORS To Produce Stain-Free Strip

The Scovill Manufacturing Company of Waterbury, Conn., long a leader in producing quality copper-base alloy strip, recently put the finishing touches to the first production installation of a controlled atmosphere aluminum strip annealing system.

This new system enables Scovill to produce controlled grain sizes, tempers, directional properties and dimensions in aluminum strip far closer than was once thought possible. And, by annealing in a controlled nitrogen atmosphere, the strip retains its original brightness.

To get the purest atmosphere in the shortest possible time Scovill selected a Gas Atmospheres' Nitrogen Generator which has since delivered extraordinary production economy ratios while requiring no more than initial adjustment.

Gas Atmospheres has long been a supplier of compact generators for producing any quantities of controlled annealing atmosphere gases at exceptionally low cost. So when next considering generated atmosphere remember it will pay you to consult Gas Atmospheres before you buy. Representatives in leading metal producing areas.

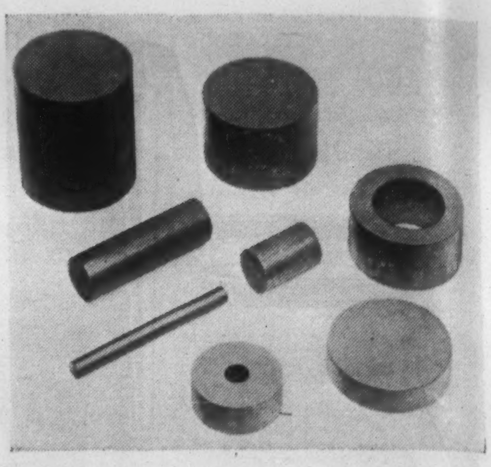


gas Atmospheres, inc

equipment for producing industrial gases

For more information, turn to Reader Service Card, Circle No. 440

New Materials, Parts, Finishes



Magnetic Plastics Core for Extreme Temperatures

A new magnetic plastics core has been developed which is said to have a high degree of stability at temperatures from −150 to 390 F, high impact strength and can be readily machined. Developed by the *Polymer Corp.*, Reading, Penna., and designated Ferrotron Type 119, the material is designed for high frequency applications in such uses as cores, filters and attenuators. The material is said to have constant magnetic permeability with frequency through 15 megacycles. It is relatively unaffected by frequency in the low megacycle range and has a low magnetic loss tangent. Slugs are available in sizes ranging from ½- to 2-in. o.d. and 1 in. long.

Pre-Cut Glass Tubing for Diodes

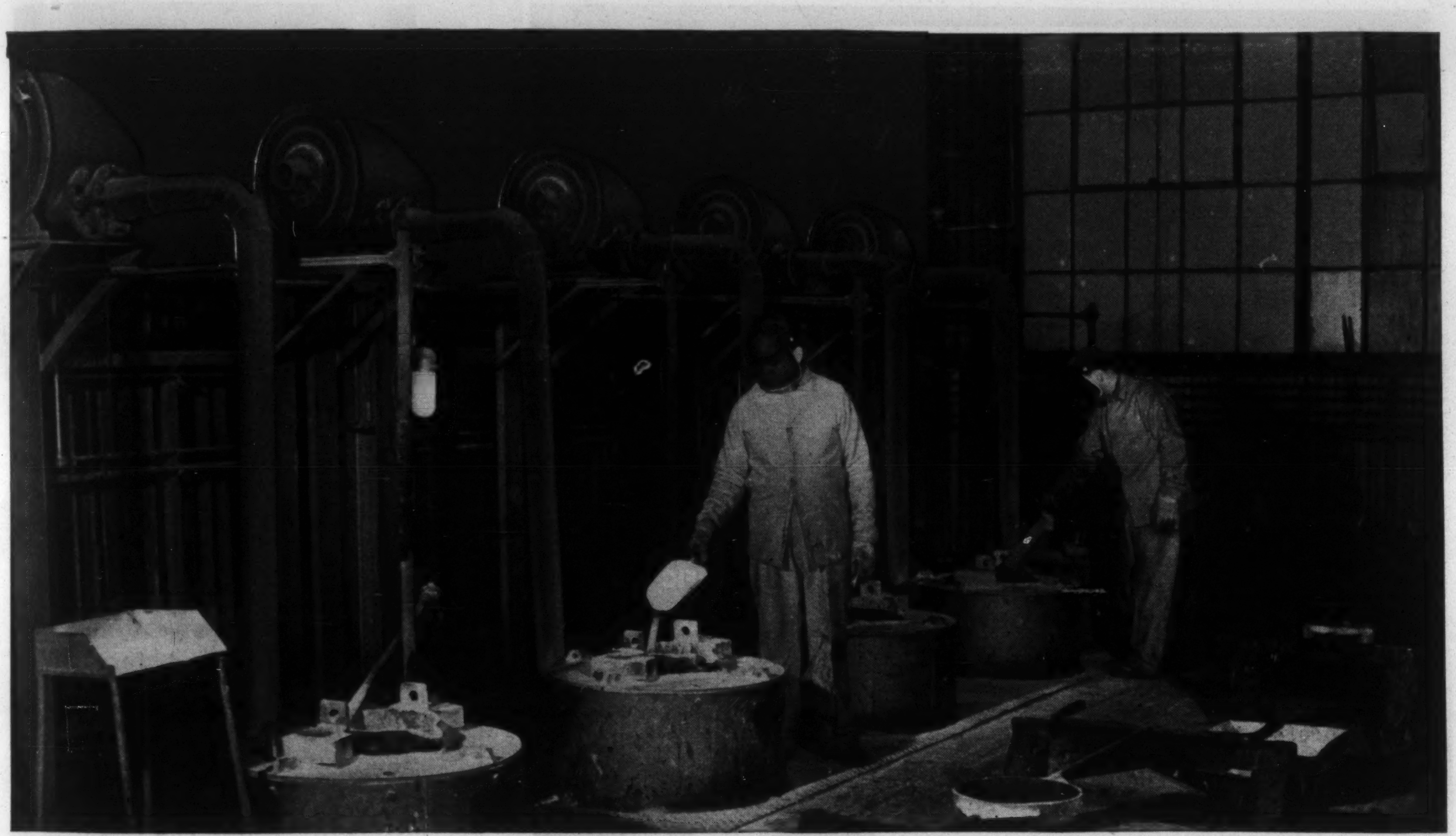
Pre-cut, ready-to-use glass tubing is being produced for hermetically-sealed all-glass diodes by *Corning Glass Works*, Corning, N. Y. It is pre-cut for both diode cases and diode sealing beads. Known as Corning G-12 glass, bead and case diameters are being produced to a tolerance of ±0.002 in., while length tolerances are ±0.004 in. on the bead and ±0.005 in. on the case. Length of the standardized glass case is 0.275 in. while o.d. is 0.095 in. and i.d., 0.060 in. Sealing beads

Nonferrous Melting with . . .

SPENCER
HARTFORD

TURBO-COMPRESSORS

There are many methods of melting non-ferrous metals but the accepted standard for furnishing air to Oil and Gas fired furnaces is the Spencer Turbo-Compressor. A battery of Spencer 5 HP turbos in the foundry of a large Chemical plant is shown below.



Thirty-five years ago the Spencer Turbo was first specified by a furnace manufacturer. Today it is the first choice of all of the leading furnace and oven manufacturers.

The reasons they prefer Spencer are the absolute reliability—perfect performance and low maintenance over long years of almost continuous service. Spencer Turbos range in size from 35 to 20,000 cu. ft. per min., 4 oz. to 10 lbs. and 1/3 to 1,000 HP.

SPENCER
TURBO COMPRESSORS

For complete description
of the standard and
special Turbos ask for
Bulletin No. 126-A.

THE SPENCER TURBINE COMPANY

SPENCER

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Manufacturers of Turbo-Compressors and Heavy Duty Vacuum Cleaners

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LIKE SPECTACULAR COST CUTTING MACHINERY . . . .
that consolidates production operations in a single machine to speed up production and eliminate wasteful handling

CMP *cold rolled strip steel*

can help step up your production rate . . .

By working to restricted specifications for size, physical characteristics and finish, realized through precision cold rolling and heat treating processes, CMP can help in many ways to step up the production of parts made from flat rolled steel.

In many cases, "working qualities" can be so improved that machine speeds can be stepped up as much as 25%.

Frequently, qualities can be developed which permit simplification of tooling.

In some instances, restricted specifications may be developed which completely eliminate operations.

Where precision fitting is encountered, dimensional accuracy can be developed to greatly speed assembly and eliminate rejections.

In all cases, users enjoy the usual time-saving advantages of CMP's customary precision gauge and width tolerances . . . more footage per coil . . . fewer production shutdowns for coil replacement on automatic-feed operations . . . longer tool life.

CMP's extensive experience in development of steel specifications for more efficient and economical production is always at your service.

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WHERE YOU CAN GET SPECIFIC SPECS. FOR SPECIFIC JOBS
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HIGH CARBON
Annealed or Tempered
STAINLESS • ALLOY
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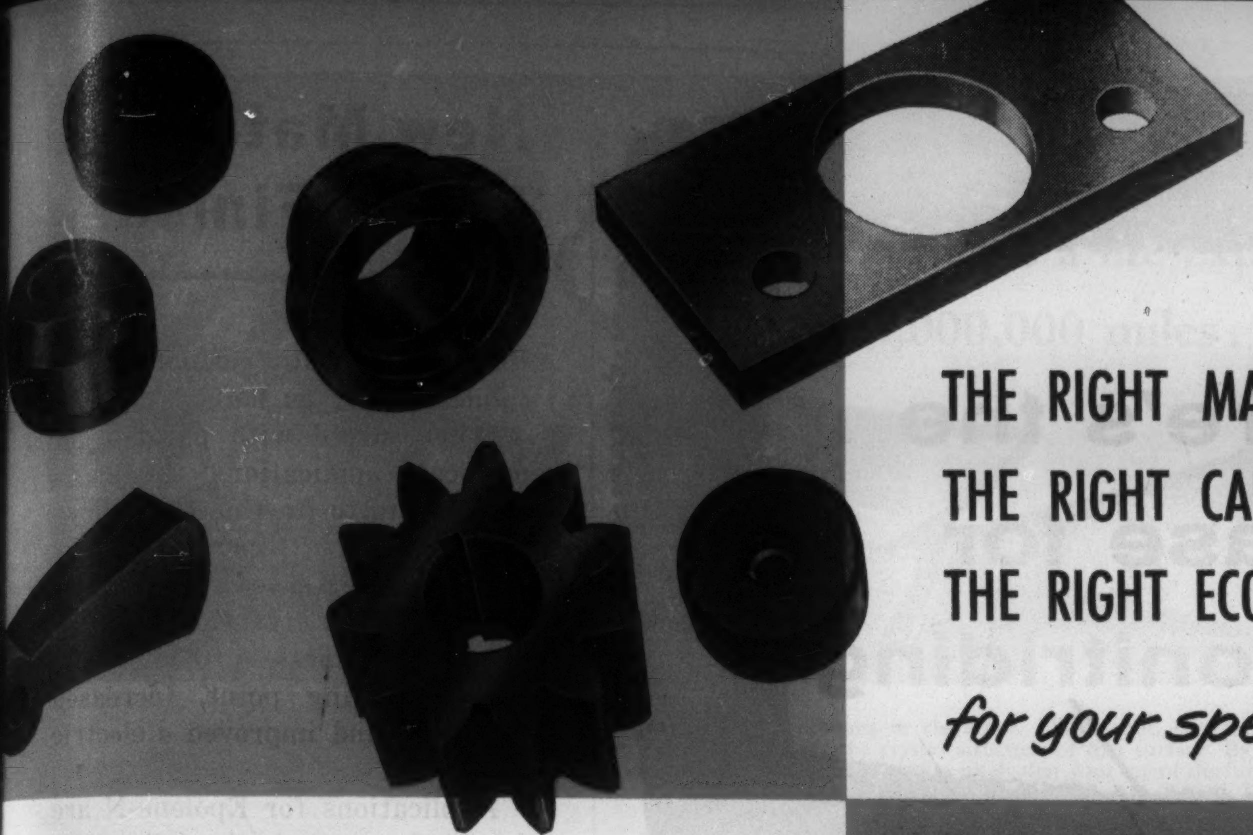
are available 0.062 in. long with an o.d. of 0.053 in. and an i.d. of 0.023 in. According to Corning, purchase of pre-cut components should increase manufacturing efficiency by eliminating waste and breakage.

Grain-Size Polyethylene Wax Aids Processing

A pellet size polyethylene wax has been developed for use in melt-coatings for a variety of packaging applications and to upgrade paraffin and other types of commercial wax. Epolene, a low molecular weight polyethylene, is available in two forms: Epolene-E, an emulsifiable type and Epolene-N, a non-emulsifiable type. The former is expected to become a major ingredient in self-polishing emulsion type waxes, while the latter is expected to find use in paste polishes, as a substitute for more expensive ingredients.

According to the manufacturer, *Eastman Chemical Products, Inc.*, 260 Madison Ave., New York, the new wax appears to be superior in many respects to other synthetic waxes, to micro-crystalline waxes, and to many expensive natural waxes. Both forms of the wax are compatible with all commonly used animal, vegetable and mineral waxes, with the exception that Epolene-N is incompat-

For more information, Circle No. 441 ➤



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Name your application: heavy-duty structural parts, pieces that must resist corrosion or heat, bearings with built-in lubrication, porous metal filters or many another item—*we'll* produce the right answers for you in material, volume and price. Send us your requirements, for prompt analysis and quotation.

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Write for this informative Bulletin B-54, detailing composition and properties of popular Keystone powdered metal grades.

Here's the Case for Carbonitriding

with

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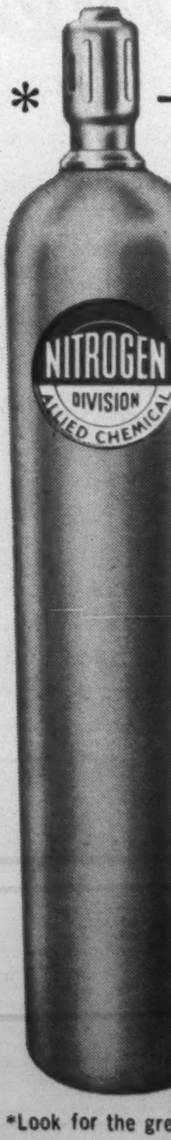
Anhydrous Ammonia



* → **Call it** "gas cyaniding," "dry cyaniding" or "ni-carbing," you get a low-cost substitute for liquid cyaniding when you use Barrett Brand Anhydrous Ammonia.

With Barrett Anhydrous Ammonia you can expect cases that will far outlast the best carburized or cyanided cases . . . *and* at lower cost too. Some costs may actually be only one-fourth as much when you use Anhydrous Ammonia.

Because carbonitriding uses Ammonia as gas, you need Barrett Brand Anhydrous Ammonia. Barrett Ammonia is dry—free of moisture. Barrett Ammonia is pure—guaranteed 99.95% pure Ammonia. And Barrett Ammonia is easily available—49 stock points from coast to coast.

Your nearest Barrett Brand Anhydrous Ammonia distributor can supply you immediately with 150, 100 or 50-lb. cylinders. He will also arrange for delivery in tank-truck or tank-car quantities. Call him today!

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Urea • Formaldehyde • Nitrogen Tetroxide • U.F. Concentrate—85
Nitrogen Solutions • Fertilizers & Feed Supplements

*Look for the green cap!

For more information, turn to Reader Service Card, Circle No. 330

ible with certain components of candelilla and ouricury.

When mixed with paraffin for melt-coat applications, the material is said to provide the following advantages: increased block resistance, increased resistance to moisture-vapor transmission, increased hardness, provision for higher melting point, increased flexibility and improved dielectric properties.

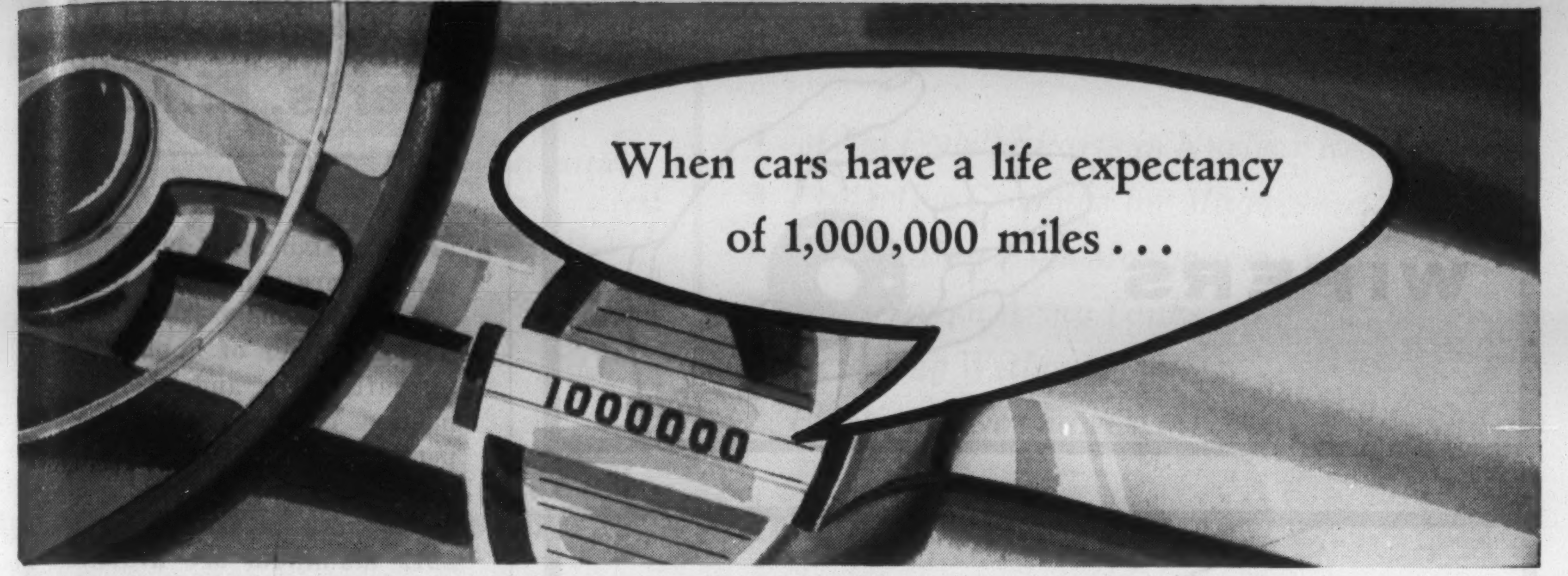
Applications for Epolene-N are expected to include the following:

1. Food packaging—Used to up-grade paraffin.
2. Coils and condensers—Used where high melting point and good dielectric properties are paramount.
3. Electrical devices—Used with those incorporating potting compounds.
4. Rubber compounding—Used in milling operations where it provides an effective calendar release agent.
5. Candle making — Increases melting point.
6. Floor, auto, furniture and shoe polishes — Provides higher gloss, hardness and scuff resistance.
7. Protective coatings—Used as flatting agent in lacquers.

The manufacturer recommends Epolene-E for use in furniture and floor polishes. Both forms of Epolene are said to be priced competitively with waxes of comparable properties.

New Aluminum For Higher Temp

A new aluminum alloy with significantly superior high temperature properties has been released by the Aluminum Co. of America. Designated X2219, the new alloy is a member of the aluminum copper group of alloys containing small amounts of other elements. In the solution heat treated and aged condition, X2219 has exceptional mechanical properties, tensile and yield strength,


When cars have a life expectancy of 1,000,000 miles . . .
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Electron diffraction can help solve problems in chemistry, physics and metallurgy. By diffracting a beam of electrons from a surface, you can identify the crystal structure of that surface. By using this technic for research into the structures of lubricants and metals, it's quite likely that your car of the future will have fantastic longevity.

chances are that research with electron diffraction will have helped make this come true

● *The General Electric electron diffraction instrument* is versatile and easy to operate. The unit consists of vacuum system, electron gun, power supply and complete camera assembly — all the components required to produce both reflection and transmission photographs from a wide variety of samples.

This instrument can perform numerous tasks for industry. In chemistry, for example, it can be used to study catalytic action . . . to analyze surface contamination as well as foreign particles. In metallurgy, it can help in the selection of corrosion-resistant materials . . . can be used to examine alloy structures and pigments. And physicists, too, find many applications for G-E electron diffraction.

Get further information from the G-E x-ray representative in your locale . . . or write X-Ray Department, General Electric Company, Milwaukee 1, Wisconsin, for Pub. AZ64.

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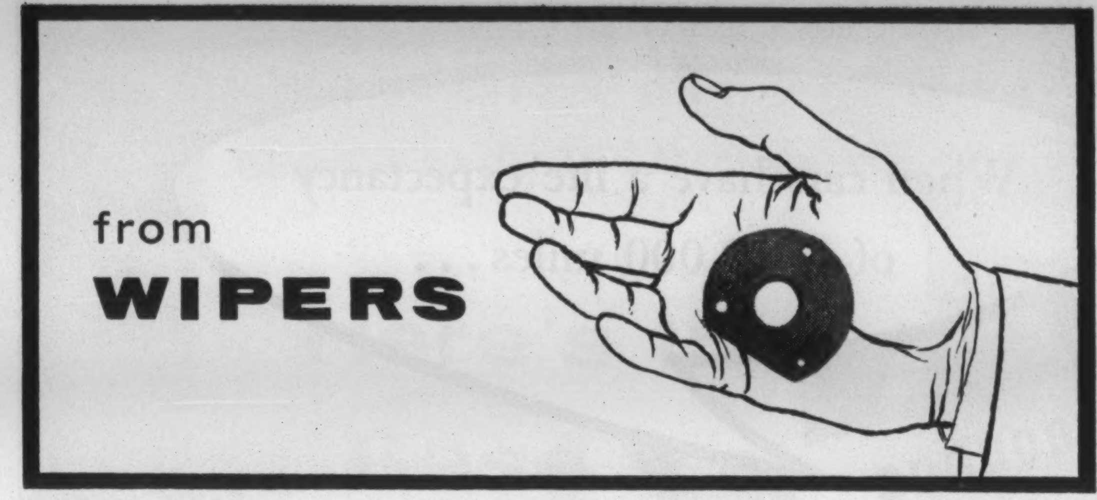

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FELTERS S.A.E. F-13 and F-15 are grades of felt recommended for sound deadening chassis strips, spacers, dust shields and mechanical purposes when abrasion and wear are not important factors.

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. . . by the roll . . . by the yard
. . . or cut exactly as you want it.

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and resistance to creep in the temperature range 500 to 600 F.

The new alloy is expected to find a number of applications in aircraft, pump, and internal combustion engine use where good performance at temperatures in the 500 F range is vital.

Experimental quantities of X-2219 aluminum are available in the form of rolled and extruded shapes and forgings. The bulk of test data were obtained from forged specimens, but experience indicates that the properties are also typical of rolled or extruded products.

Properties

The improved properties of the new alloy are evident when compared to 2216 aluminum, which is a standard alloy that has been used for high temperature service for some time. The new alloy, as might be expected, sacrifices some ductility for its higher strength. Minimum room temperature properties of X2219 for tentative acceptance purposes are 55,000 psi min tensile, 35,000 psi min yield, and 6% elongation. Typical properties of batches have been higher, averaging 62,000, 43,000 and 16%, respectively. Elevated temperature figures for the new alloy compared to 2218 = T61. at 100-hr exposure are:

	Tensile	Elong
At 500 F		
X2219 T6	29,000	24%
2218 T61	13,000	50%
At 600 F		
X2218 T6	18,000	26%
2218 T61	6000	75%

Stress for rupture in 100 hr at 600 F is 9500 psi for the new alloy and 3900 psi for the old.

Stress for 0.2% creep in 100 hr at 600 F is 6700 psi and 2300 psi respectively.

Fatigue strength—10^8 cycles at 600 F — is 5500 psi for X2219 and 5000 psi for 2218.

The weight per cu in. of the new alloy is 0.102 lb.

Contents Noted

A digest of papers, articles, reports and books of current interest to those in the materials field.

This Month:

- *Metal Powder Parts in Nuclear Reactors*
- *Protective Coatings for Magnesium*
- *Fabricating High Manganese Copper*
- *Titanium in Army Tanks*
- *Descaling Without Acids*
- *Plastics in German Cars*

Applications of Powder Metallurgy in Nuclear Reactors

The metallurgical problems involved in designing nuclear power reactors include mechanical behavior of metals at elevated temperatures; corrosion behavior; thermal conduction; heat transfer characteristics and effects of radiation. Radiation effect is probably one of the most important of these problems. Experience in the field is limited and experimental results are still incomplete.

Interestingly enough, most of the changes in physical properties of metals that occur on exposure to neutron radiation resemble the changes occurring as a result of cold-working, although the mechanism, to be sure, is quite different. In a paper delivered before the American Society of Mechanical Engineers' Diamond Jubilee Spring Meeting in April, Dr. H. H. Hausner and Dr. M. C. Kells, both of the Atomic Energy Div., Sylvania Electric Products, Inc., described the role powder metallurgy might play in designing nuclear reactors of the future. The authors point out that metals seem to be affected chiefly by neutrons. Some of the experimentally observed disturbances in metals can be explained and correlated on the basis of a lattice vacancy picture which considers displacements of atoms from their normal crystal lattice positions. It is understandable that kinetic energy of a fast neutron is high enough to displace atoms during an elastic collision and thus to disrupt the material. As a result of such collisions, a number of lattice vacancies may be created and the removed atoms also may displace still other atoms from the lattice.

It has also been noted that radiation increases the hardness very little in hardened metals, though it provides an appreciable increase in hardness of annealed metals. It seems that lattice dislocations and defects produced by hardening substantially lower the effect of radiation; thus radiation effect is closely connected with the degree of disorder in the lattice structure. Any powder particle is characterized by a high ratio of surface area to mass or volume. The surface crystal lattices are usually different from the body lattices and show a large amount of lattice vacancies, dislocations or other disturbances. This disordered effect is furthered by the powder metallurgy compacting process which utilizes pressures between 5 and 50 tsi, but which are even greater in areas where the particles touch each other. The resulting disordered lattices may make a material more resistant to radiation effect, thus offering definite advantages as a method of fabricating materials for nuclear power reactors.

Powder metallurgy alloys

Certain alloys made from fissionable materials with small alloy additions are more favorable with respect to radiation effect and corrosion than pure fissionable material. Preparing alloys by powder metallurgy methods offer certain advantages, particularly in respect to alloys made from very heavy metals such as uranium, and very light metals. Ordinary melting of two components with quite a difference in density frequently results in segregation of the two components, and one or more remelting steps may have to be added in order to obtain a homogeneous alloy structure. Remelting involves the danger of inclusion of gaseous impurities. By mixing the components in powder form, a homogeneous structure is obtained without danger of contamination.

Heat transfer

Certain reactor parts such as fuel elements must be clad with another metal to prevent corrosion under operating conditions. In some applications the cladding must be well bonded in order to create the optimum conditions of heat transfer, which plays an important role in several reactor components. Powder metallurgy offers some advantages in this respect.

Diffusion of one metal into another usually requires high temperatures or long-term treatment at lower temperatures. Both conditions are not always in the range of practicality for production operations. Metal-powder particles, because of their high curvature and large number of lattice defects, usually diffuse at lower temperatures, and within a shorter time, than cast metallic bodies. By using powder metallurgy techniques in cladding reactor components, conditions can be created which result in perfect heat transfer while minimizing other deleterious effects.

The four "new" metals which play an important role in nuclear

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power reactors are uranium, thorium, beryllium and zirconium. Uranium and thorium are fuel materials; beryllium is an excellent moderator, and zirconium can be used as a cladding material for corrosion protection. All four metals can be manufactured by powder-metallurgical methods. The preparation of their powders is well established. The authors caution that handling these powders is not as easy as handling copper, iron or other ordinary metal powders. Beryllium powder is highly toxic, zirconium is highly pyrophoric and powders of uranium and thorium are both toxic and pyrophoric. However, dry boxes have been developed to handle them safely.

The authors conclude that the next few years will determine whether the steadily growing field of powder metallurgy will have its place in development and production of components for nuclear power reactors.

Recent Protective Coatings for Magnesium

A suitable protective coating for magnesium alloy surfaces, in order to meet requirements for most applications, must: 1) possess high electrical insulation properties to protect the metal from galvanic corrosion; 2) protect the metal from attack by sea water or other corrosive atmospheres; 3) protect the surface from wear and abrasion; 4) have good heat-insulation properties; and 5) provide a good surface for paint adhesion. All effective chemical and electrolytic protective coatings have one or more of these properties in varying degrees. In a paper delivered before the Tenth Annual Meeting of the Magnesium Association in November last year, P. Zylstra of Brooks & Perkins reported on 6 recently developed, electrolytically applied coatings for magnesium. They are: 1) full HAE treatment, 2) oatmeal HAE coating, 3) full Dow 17 treatment, 4) thin Dow 17 treatment, 5) low

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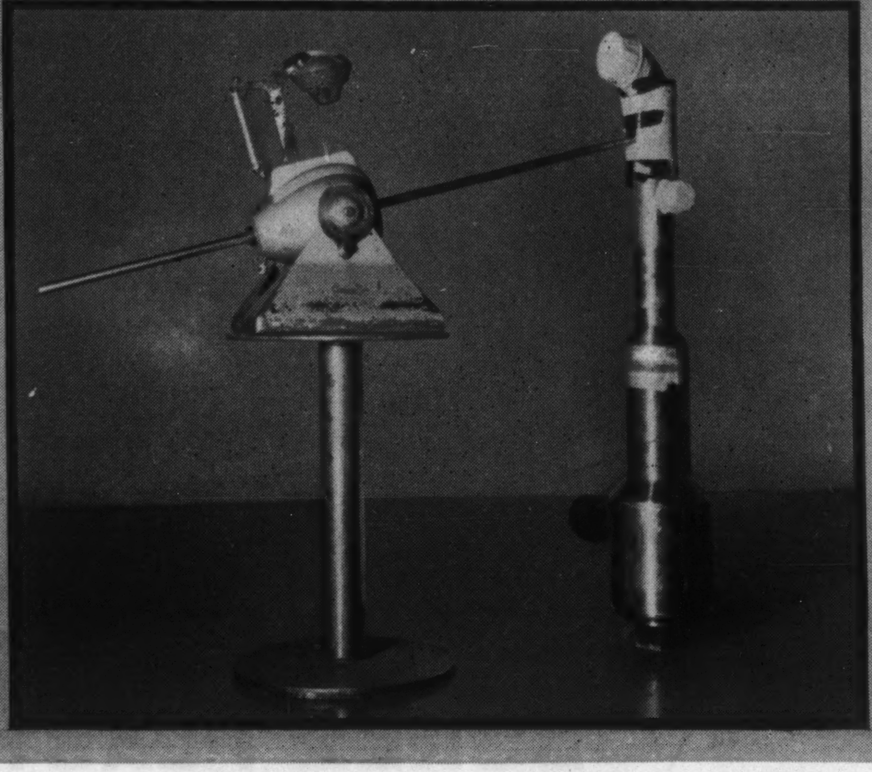

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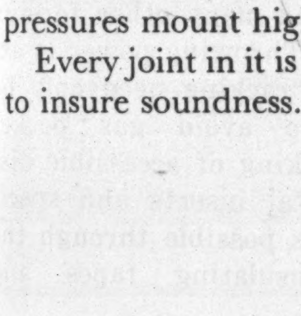

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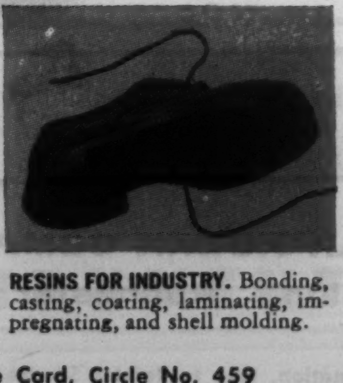

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Contents Noted

voltage modification of HAE treatment and 6) Cr-22 anodic treatment.

HAE coating

The HAE process (named after H. A. Evangelides, inventor) is one of anodic oxidation, producing a coating composed of metallic oxides. The surface appearance is light brown in color. It is porous, uniform and consistent. For practical applications, build-up is about 1 mil. It can be applied to all magnesium alloys; it has good corrosion resistance, excellent abrasion resistance, heat resistance, thermal shock resistance and good dielectric properties. It serves as a good paint base and is a one-step treatment.

The bath is alkaline in nature, and a minimum of control is necessary due to its good stability. Pretreatment consists of removal of organic contaminants such as oils, grease and paints. The process itself removes sand, graphite and many other foreign materials. Throwing power is excellent and racking need only be designed to avoid gas pocket areas. Masking of accessible dissimilar metal inserts and specified areas is possible through the use of insulating tapes and waxes.

Oatmeal HAE

In the first few minutes of treatment in the HAE tank, the coating unites chemically with the surface layer of magnesium, and there is a slight build-up. The build-up has a light oatmeal color, hence its name. It has good corrosion resistance and somewhat better abrasion resistance than bare magnesium, though not as good as the full HAE treatment. This coating can be applied in a fraction of the time required for the full treatment and has been found suitable for use in applications where extreme protection and abrasion resistance are not required. A recent application of the oatmeal-type coating shows promise in lengthening the life of magnesium printing plates. This type of coating does not

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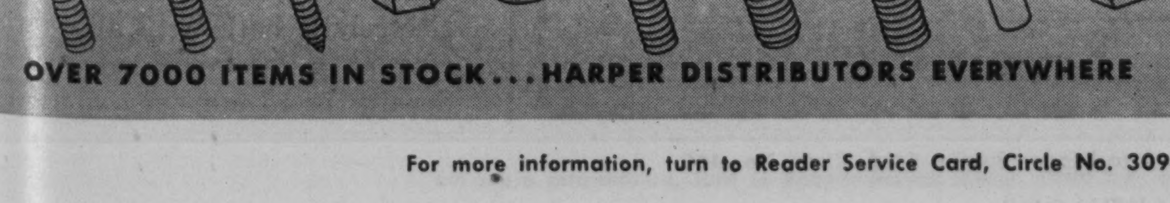

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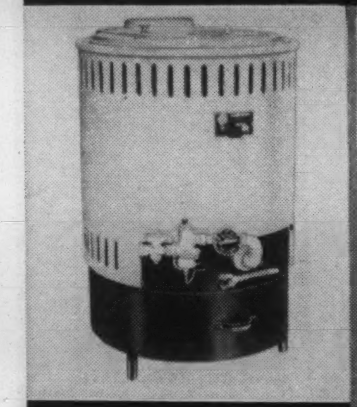
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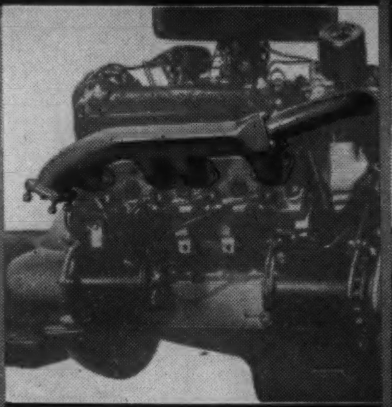
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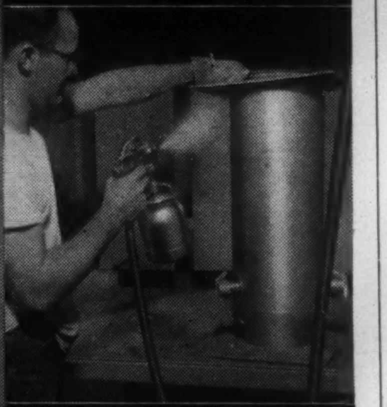
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Contents Noted

affect the printing quality of the plate.

Dow 17 anodic

The Dow 17 Anodic Coating is applied in the same manner as HAE. It is green in color and has many of the same properties as HAE. Time required for application is somewhat less than that required for HAE. It has excellent corrosion resistance; however, its hardness and abrasion resistance appear inferior to those of HAE coatings. When abrasion resistance and hardness are not considerations, the two coatings are interchangeable.

Just as a thin original coating is a modification of HAE, so a similar coating is formed when applying Dow 17. This coating is similar in properties to the HAE oatmeal coating. Though extensive comparative test results are not available, it is probable that the two coatings can be used interchangeably.

Low voltage modification of HAE

In the development of HAE, various modifications were tried, one of which was a low-voltage coating. It can be applied in a short time and being applied at low voltage is not self-cleaning. The appearance is similar to a heavy dichromate dip coating. After deposition it is given a sealing treatment in a hot dichromate solution, which is not rinsed off. It would appear that conditions of application and sealing are quite critical with this treatment. Salt spray test results have varied from specimen to specimen and lot to lot. On the basis of limited test experience, the author doubts that the coating will be satisfactory for use on production jobs.

Cr-22 anodic coating

The recently developed Cr-22 coating is green in color and has a much smoother surface than either HAE or Dow 17. It is applied by anodic treatment in an electrolytic bath with alternating current. Recommended current density is 15 amp per sq ft, but

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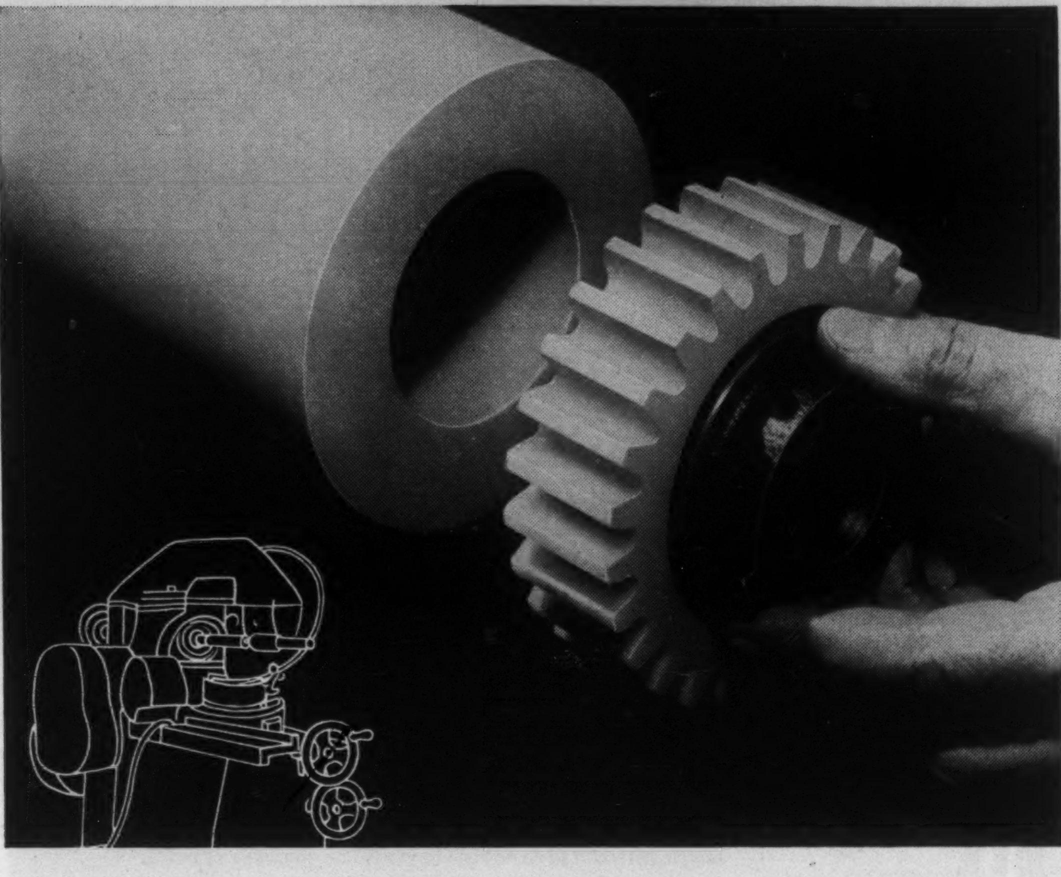

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wide variations are possible. Treatment time is dependent on current density, temperature, and final voltage but should not exceed 12 min. No pre-treatment is required other than usual degreasing. Four-by-six inch magnesium panels usually show no corrosion after 48 hr in 20% salt spray. After 120 hr these panels average 1 pit. This protection is achieved without use of post treatments. The coating requires 500 to 600 v to cause dielectric breakdown. Hardness of coating is such that it will abrade copper and mild steel. The coating can be applied successfully to AZ-31, AZ-61, AZ-92, AZ-63, ZK-60, ZR E1, Z5Z and M1 alloys. Force required to separate the coating from the base metal by pulling at right angles to the panel surface is 2500 psi.

A note of caution

The author points out that some engineers are still looking for the one coating which will have perfect adhesion, unlimited resistance to salt spray and cyclic humidity, extreme hardness and abrasion resistance, unlimited flexibility, resistance to high temperatures and good electrical conductivity, so that grounding will be no problem. Some desirable characteristics are diametrically opposed to others. No one finish can meet the requirements for every service application.

Precautions in Fabricating High Manganese Copper Alloys

Manganese-copper alloys containing 60% or more electrolytic manganese exhibit an unusual combination of high vibration damping capacity with good strength properties. A wide field of application in structural and machine design seem obvious. However, serious difficulties in commercial fabrication of structural or machine components from

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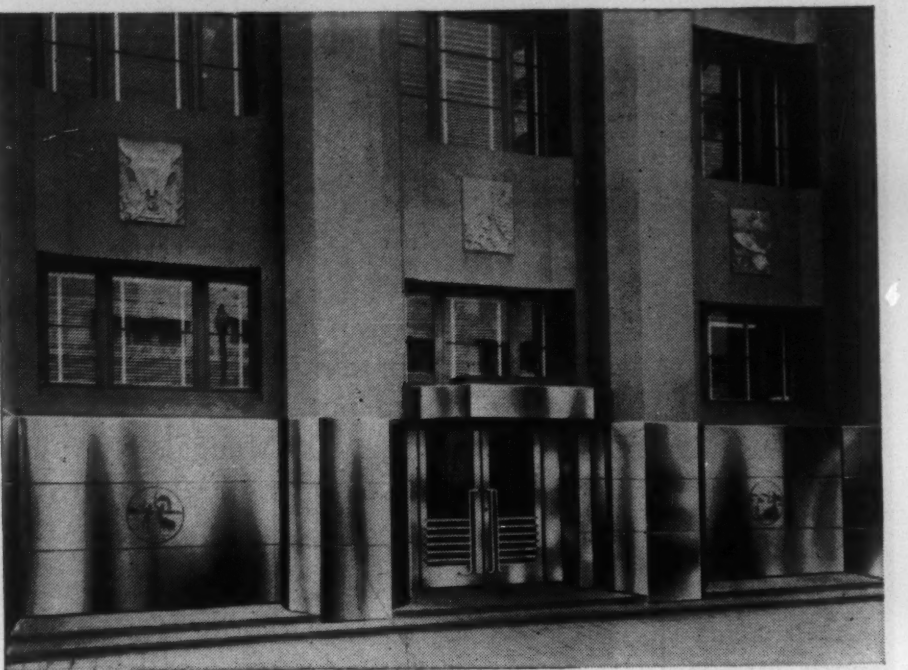

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the alloys have retarded their practical utilization. For this reason the Federal Bureau of Mines, in cooperation with the U. S. Navy, Bureau of Ships, undertook development of practical fabrication methods of a selected group of these alloys. In April, Bureau of Mines Report of Investigation 5127 was published in which J. A. Rowland, C. E. Armantrout and D. F. Walsh summarized a part of that investigation.

Precautions in casting

There are certain precautions that must be taken if the alloys are to be fabricated into satisfactory structural and machine components. The solubility of carbon in manganese-copper alloys should be recognized, and the detrimental effect of 0.05% or more carbon should be guarded against. Calcium should be used as a conditioning addition wherever possible. If it should be necessary to use either aluminum or magnesium as a substitute, additions must be made with due caution and after careful experimentation to develop a practice adapted to the particular case.

Mold design is of primary importance. Because of the extraordinary shrinkage characteristics of these alloys it is imperative that mold and hot-top have proportions that will compensate for the strong tendency toward secondary piping typical of all high-damping compositions.

Precautions in working and heat treatment

No unusual difficulties are encountered in hot- or cold-working sound ingots. The alloys are somewhat more resistant to deformation than commercial steels, but any increase in the hot-working temperature above the established maximum should be carefully avoided. With proper consideration for this hot-working limitation, the entire series of alloys can be fabricated easily according to usual working practices.

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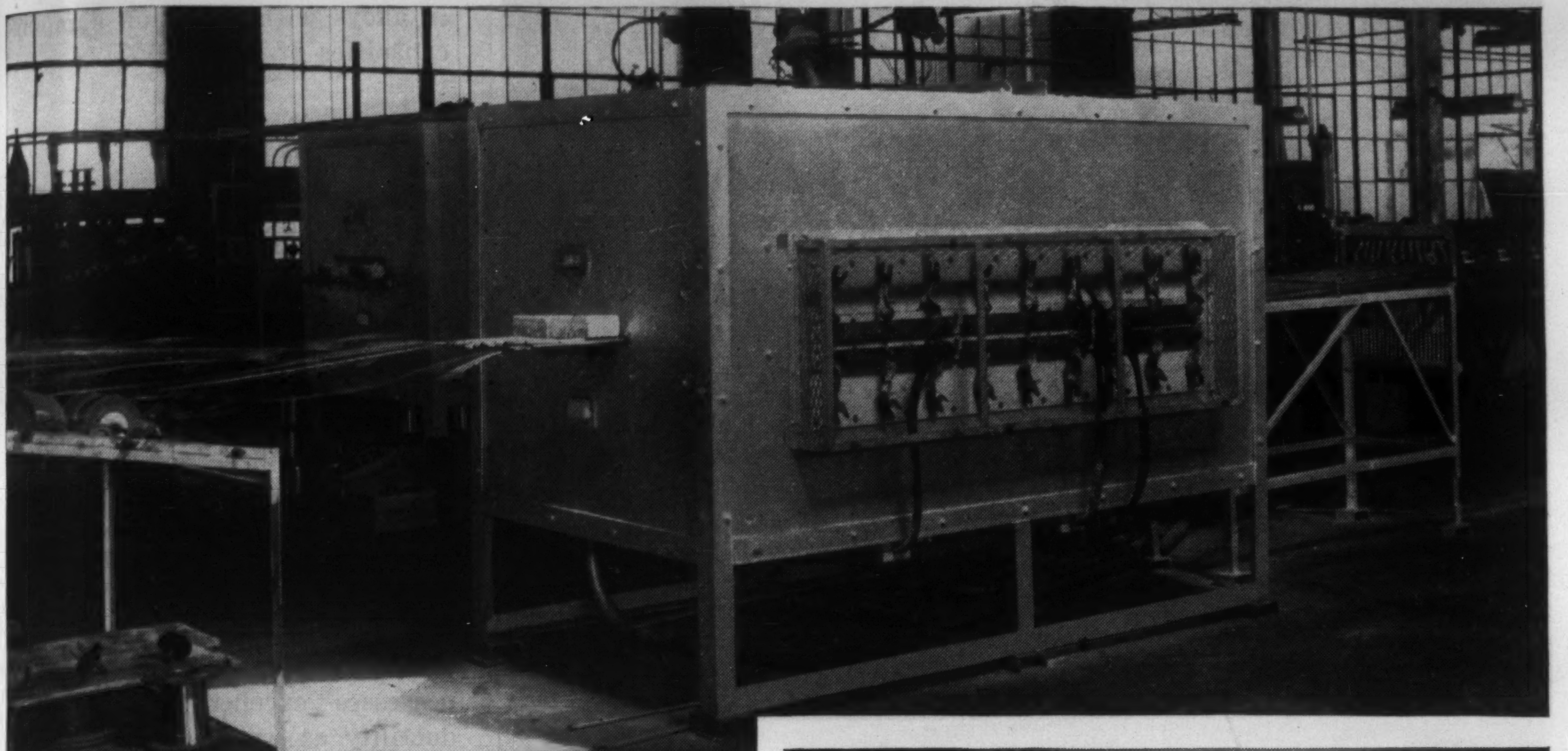
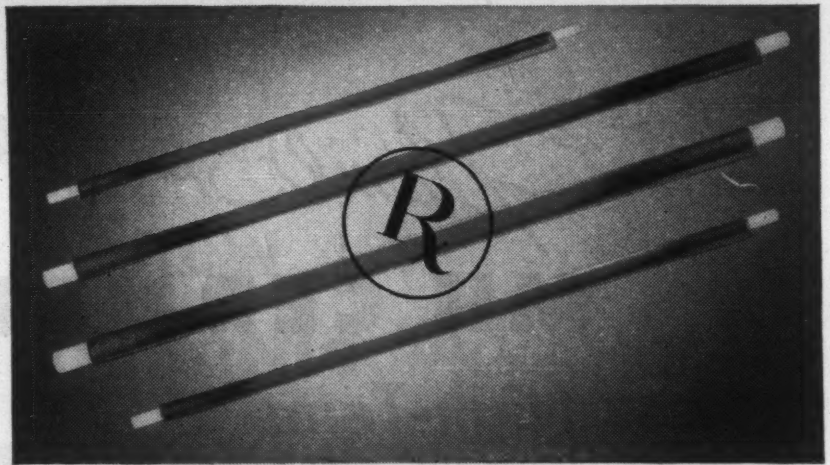


Completely Equipped With "Hot Rods" after Norton CRYSTOLON heating elements proved their ability to outlast others 3 to 1. This electric furnace is one of a battery operated by the Alloy Metal Wire Division of H. K. Porter Company, Inc. of Prospect Park, Pa., for bright annealing alloy wire at 2150F. Heating elements operate in an air atmosphere, while the wire passes through tubes containing a controlled split-ammonia atmosphere. These furnaces idle at 1700F-1750F on weekends and holidays, so element service is continuous.



Norton CRYSTOLON Heating Elements, or "Hot Rods", are a typical Norton ℞ — an expertly engineered refractory prescription for greater efficiency and economy in electric kiln and furnace operation. Made of self-bonded silicon carbide, each rod has a central hot zone and cold ends. Aluminum-sprayed tips and metal-impregnated ends minimize resistance and power loss. Available in standard sizes.

Alloy Metal Wire Division H. K. Porter Company, Inc. converts to CRYSTOLON heating elements after tests prove superiority of latest Norton ℞*

Like many another new user of "Hot Rods" the Alloy Metal Wire Division of H. K. Porter Company, Inc. found that these Norton CRYSTOLON heating elements last much longer. Here is a summary of the tests responsible for this company's decision to make a complete change-over to "Hot Rods."

Electric furnaces at the company's Prospect Park plant are used for bright annealing alloy wire at 2150F. Previous heating elements had given approximately 4 to 6 months service with 3,048 hours as the best recorded service life. Then, in a furnace completely equipped with "Hot Rods" the Norton elements averaged 18 months of continuous service — or over 13,000 hours per element. Once again "Hot Rods" proved their ability to outlast competitive elements — by better than 3 to 1!

But that's not the whole economy-story. The much longer life of "Hot Rods" also means savings in element costs, because fewer "Hot Rods" are needed — *plus* reduced maintenance, due to less frequent changing — *plus* fewer changes in voltage taps — *plus* a smoother production flow.

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in your own electric furnaces or kilns. The big illustrated booklet, *Norton Heating Elements,* gives complete details on how this proved Norton ℞ cuts operating and maintenance costs. For your copy, write to NORTON COMPANY, 345 New Bond Street, Worcester 6, Mass.

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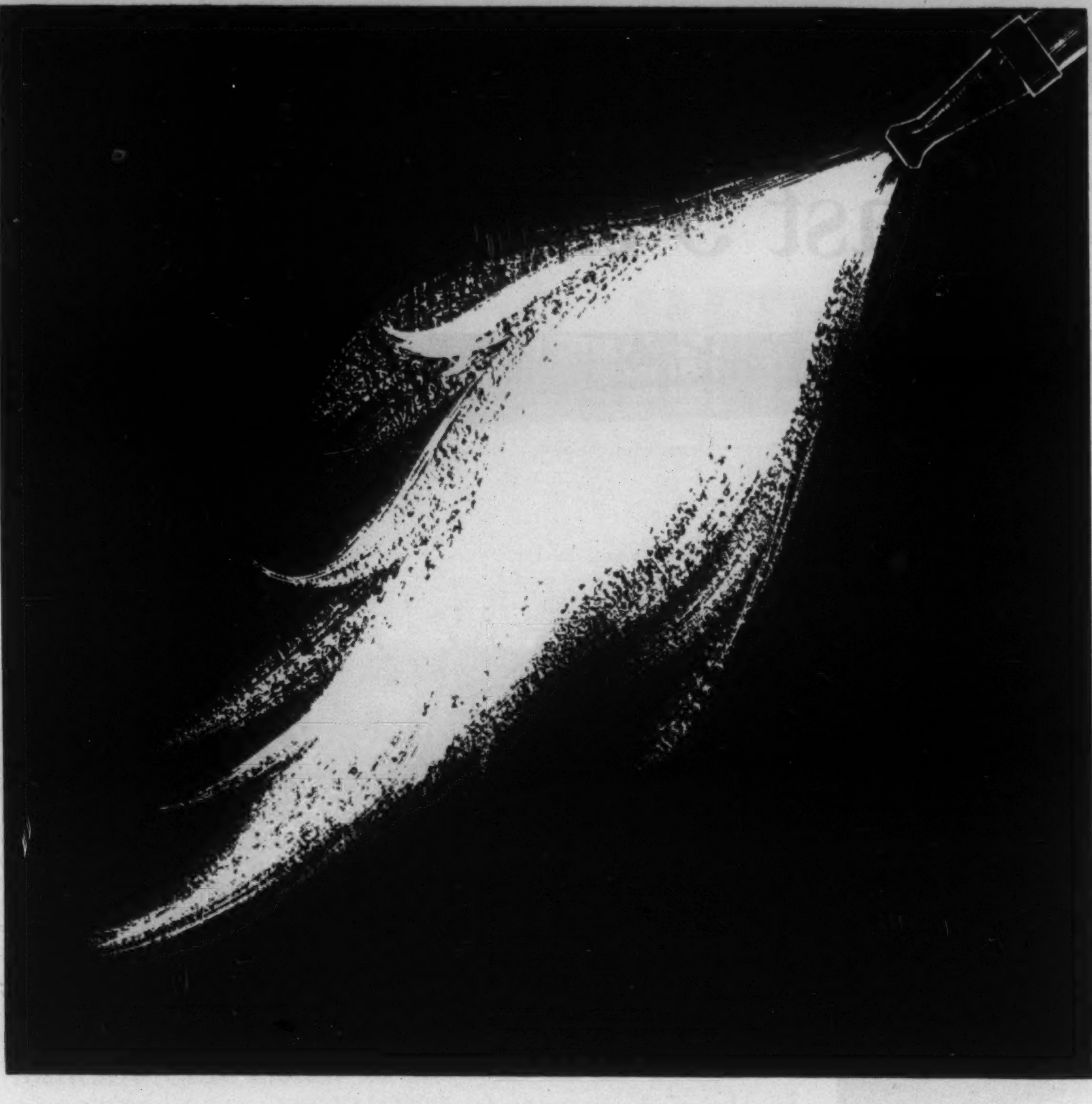

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tion treatment followed by aging. With the appropriate heat treatments, tensile strengths in excess of 100,000 psi can be developed in alloys with vibration damping capacities of 30 to 40%.

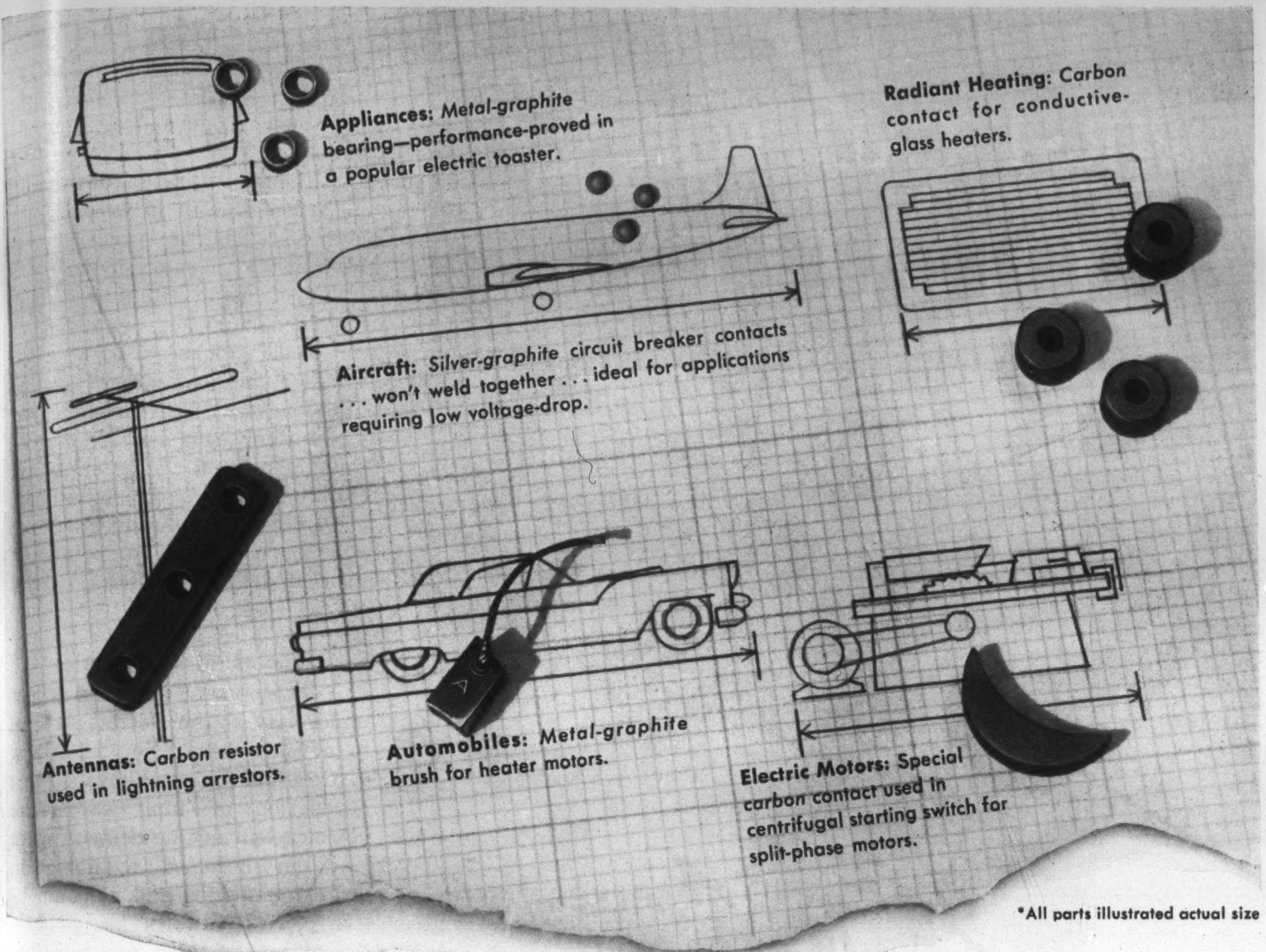
Titanium in Military Tanks

Many automotive and tank vehicles today would be less expensive and more efficient if they were manufactured from a light weight, high-strength and extremely corrosion-resistant metal. Titanium and its alloys possess these qualities. Titanium is equivalent in strength to most heat-treated steels and is only 56% as heavy; its resistance to corrosion is considerably better than that of aluminum or steel, and it possesses excellent qualities of ductility as well as high fatigue values. It is true that special manufacturing techniques may be needed for welding, machining and other fabrication processes; however the problems are not insurmountable.

In a paper delivered on the Society of Automotive Engineers' Automotive Ordnance Day in February, J. G. Stefanich of the Detroit Arsenal discussed the potentials of titanium for tank-automotive components, stressing both the advantages and the manufacturing difficulties involved. Mr. Stefanich summarized the possible advantages as follows: 1) smaller suspension components; 2) less ground pressures; 3) less horsepower required; 4) increased cruising range; 5) lighter units expediting servicing and facilitating airborne operations; 6) improved mobility and more efficient for maneuvering; 7) amphibious potentialities; and 8) increased fuel economy.

Where it would be used

A suspension system in a combat tank accounts for approximately 25% of its weight. If made of titanium, the reduction in weight would amount to about 2.5 tons; in an M47 medium tank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*All parts illustrated actual size

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it would produce a 5% weight reduction.

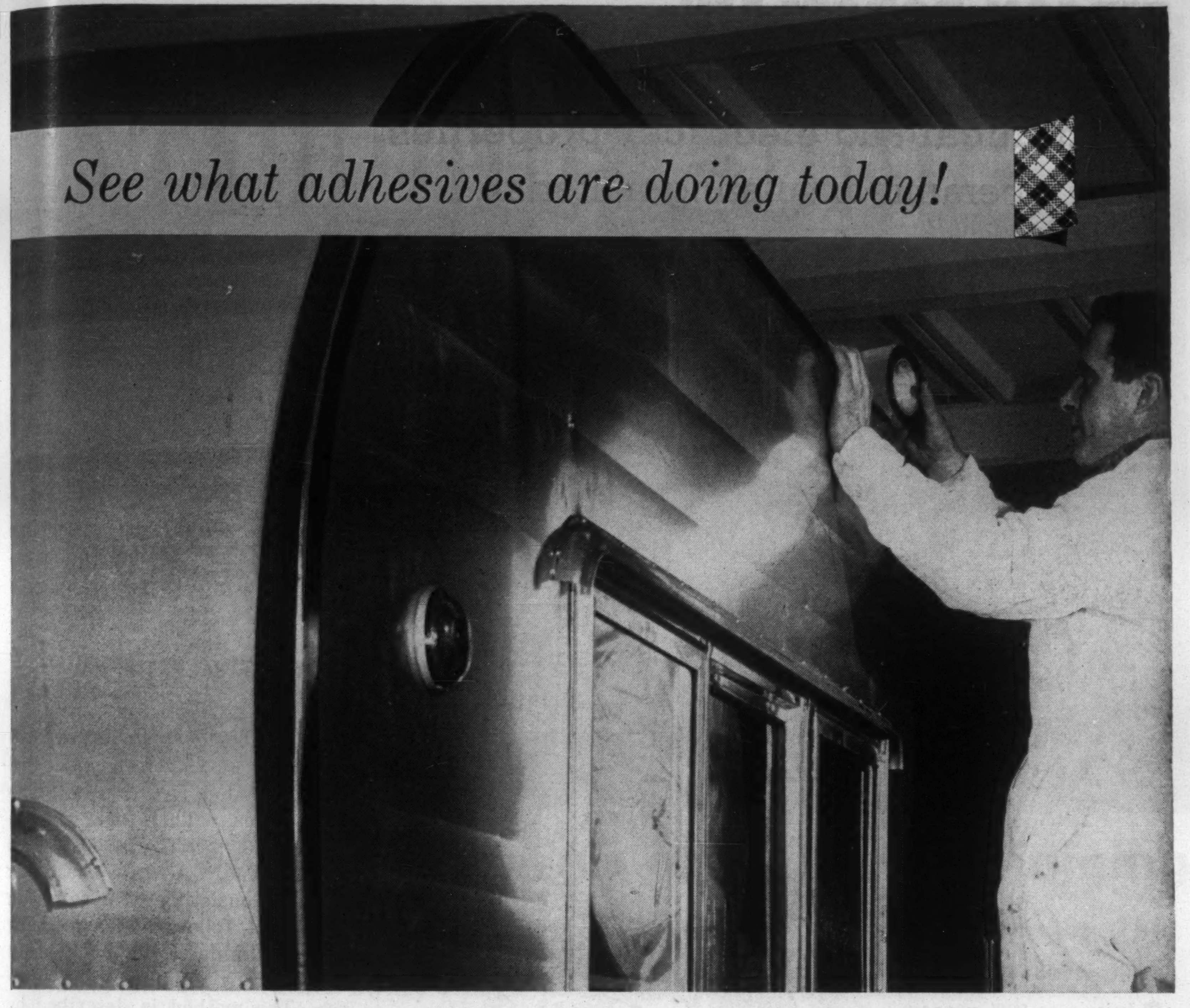
Although utilization of titanium as armor is still in experimental stages, sufficient progress has been made to suggest the possibility of using titanium in lieu of rolled, homogeneous armor on an equal thickness basis. This would result in a weight savings of 40% in the armor employed. The author emphasizes, however, that the present characteristics of titanium for armor have been determined after investigations which are only in their infancy, in comparison to those carried out on steel.

Deficiencies of titanium

A development program is now under way at the Detroit Arsenal to develop fabrication know-how of titanium and its alloys, so that production of tank automotive vehicles will not be delayed when titanium becomes available in larger quantities and at competitive prices. Studies are primarily concerned with arc welding, forming, forging and machining, in order to overcome the natural deficiencies of the material.

The author summarizes these deficiencies as follows:

1. Titanium is not suitable for use at temperatures above 800 to 1100 F, though its melting point is 350 deg above that of steel.
2. Ultimate yield strength drops rapidly above 800 F. In cases where this decline can be tolerated, the irreversible absorption of oxygen and nitrogen in most titanium alloys causes brittleness, and extended exposure renders the metal unfit for structural use.
3. Some grades of titanium have a tendency to creep and will slowly fail under constant static loads. Fortunately, this behavior can be eliminated by cold working.
4. There is a tendency to gall where sliding contact is involved. Surface treatments are being studied as a solution to this problem.
5. Titanium is not weldable to dissimilar metals, a characteristic common to other structural materials. Brazing titanium to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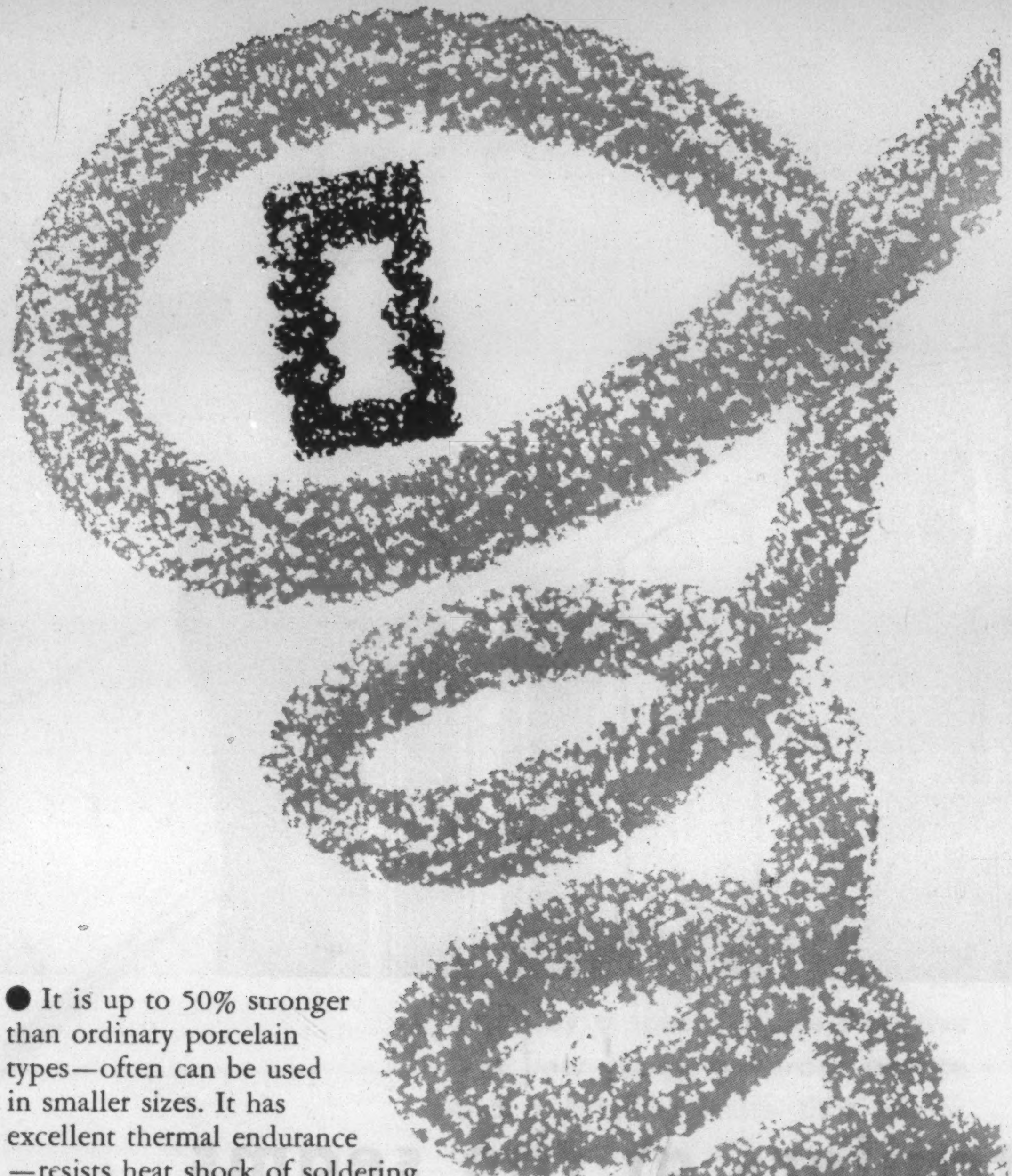

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dissimilar metals is still unsatisfactory.

6. Unalloyed titanium has a modulus of elasticity of 15 million psi and this can be increased to about 16 million psi by alloying. This modulus compares favorably with that of aluminum, 10.4 million, but poorly with that of steel, 29 million.

7. Casting titanium is still impractical.

The author concludes that although there is much work yet to be done, results thus far assure titanium's use in tank automotive vehicles once production is increased and price reduced.

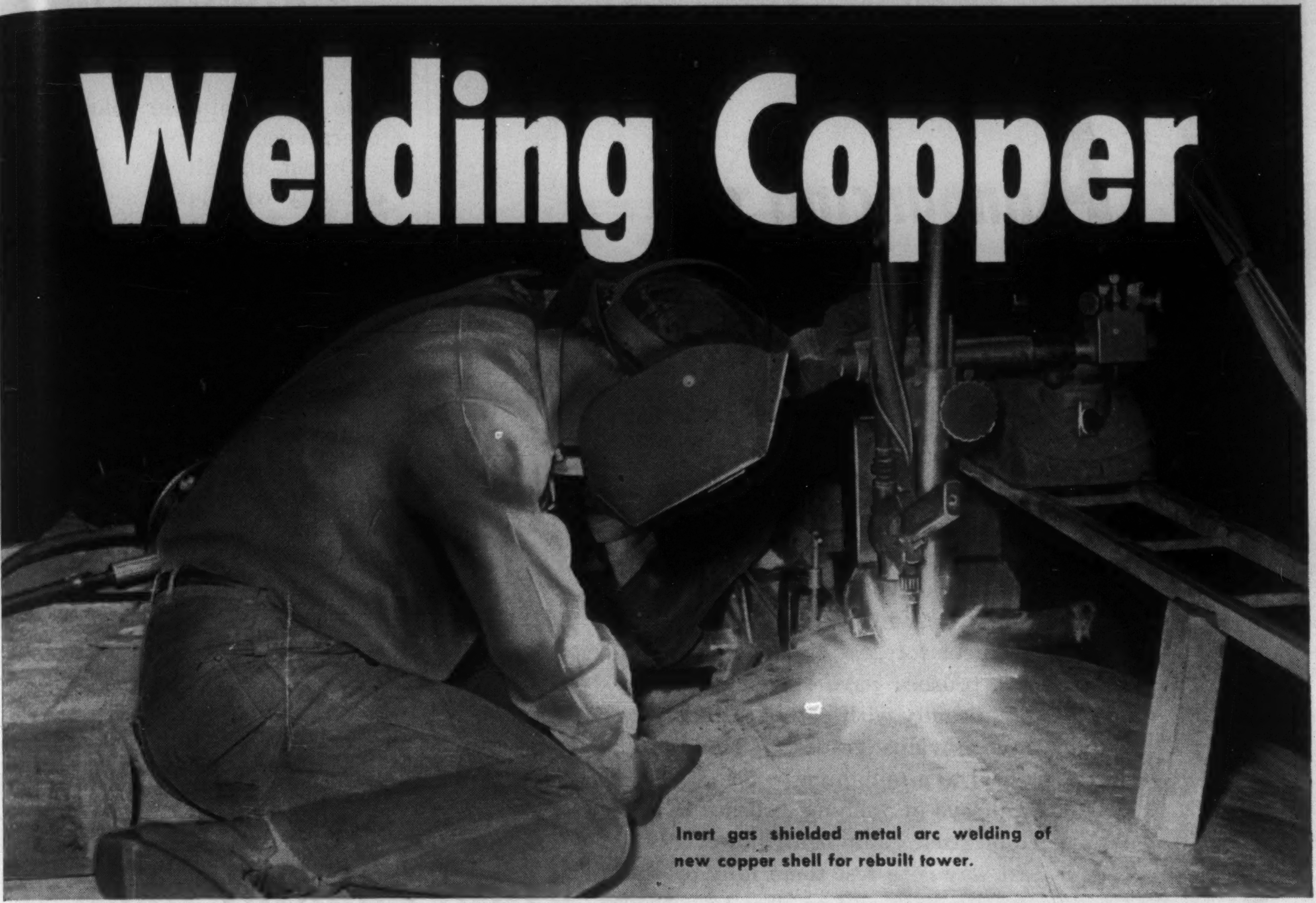
Descaling Without Acids

High alloy corrosion- and heat-resistant steels form scale that cannot be dissolved easily in mineral acids. Therefore conventional acid pickling is costly and troublesome. A new descaling method consisting of a salt bath treatment, followed by a reducing anneal eliminates the use of acids and thereby simplifies the process. The method is described by B. Wenderott in the Feb. 10 issue of *Stahl und Eisen* (German) this year.

The steel is first treated in a molten salt bath consisting of a mixture of sodium hydroxide and sodium nitrate at 750 to 930 F. During the treatment, chromium, manganese, silicon, titanium and molybdenum are dissolved in the scale leaving behind a dark coating of oxides and ferrite-type compounds of iron, nickel and copper. The steel is then washed and subjected to a reducing anneal, generally in dissociated ammonia, which reduces the oxides and produces a thin layer of iron or an iron-nickel alloy on the surface. In this condition, the surface is at least as good as the surface produced by normal pickling and in most cases can be used without any subsequent treatment.

The method is particularly suit-

Welding Copper



Inert gas shielded metal arc welding of new copper shell for rebuilt tower.

SAVES 38% in materials and labor for joining

Some time ago, the Tennessee Eastman Company, Kingsport, Tennessee, a Revere customer, began to rebuild some of its copper stills or fractioning towers, which previously would have been silver-brazed. Revere's welding specialists were called in to see whether or not welding would be superior. Demonstrations were made to Tennessee Eastman engineers and shop personnel, with the result that welding was adopted. Actual experience in the shop shows a saving of 38% in materials and labor for joining, and a better job in every way. The welding method used is the inert gas shielded metal arc process.

Reconstruction of the towers was made to reduce the number of flanges. At the same time Tennessee Eastman changed from the flange joint tray construction to the inserted tray type and incidentally, reduced the number of gaskets with their accompanying maintenance problems. The trays are salvaged by shearing off the bolt hole circle and folding up the edges. The towers are some 45' high, 6' to 10' in diameter, with a tray or bubble cap plate at specified intervals. Tennessee Eastman plans to rebuild several towers a year in this economical way.

It will pay you as it did Tennessee Eastman to look into welding as a modern method of joining copper. Remember Revere is fully experienced in the most modern and efficient methods, and will collaborate with you on their application.

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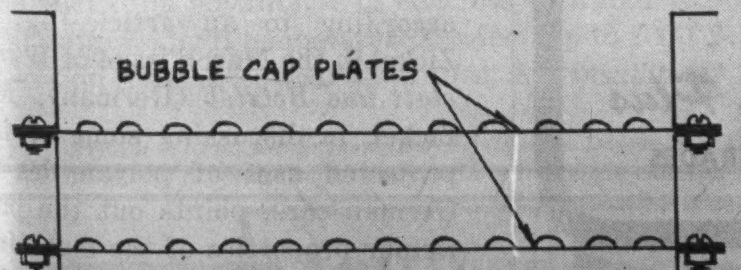
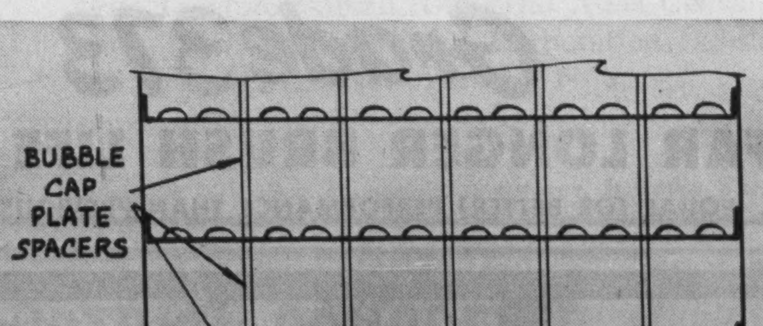


Section through old tower, showing bubble cap plates held in bolted flange.



Section through new welded tower. Bubble cap plates have had bolt holes sheared off, edges turned up. They are held in place by spacer rods.

For more information, turn to Reader Service Card, Circle No. 384

Announcing a

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IN SMALL MOTOR BRUSHES

Exhaustive tests indicate that Stackpole Grade 373 fractional horsepower motor brushes represent a major development in their field.

On vacuum cleaners, food mixers, sewing machines, calculators, and similar equipment, these new brushes have shown *materially* longer life, usually with better performance than any previous grades. Commutator wear is held to a minimum.

As always in applying brushes to any given motorized equipment, however, the one best way is to test them fully on that actual equipment and as close to possible under its typical operating conditions. Stackpole welcomes the opportunity to make or to facilitate such a test for you.

Solely on this basis of positive performance proof, it now becomes pretty clear that Grade 373 brushes will set new life and performance standards for small motors in a wide diversity of uses.

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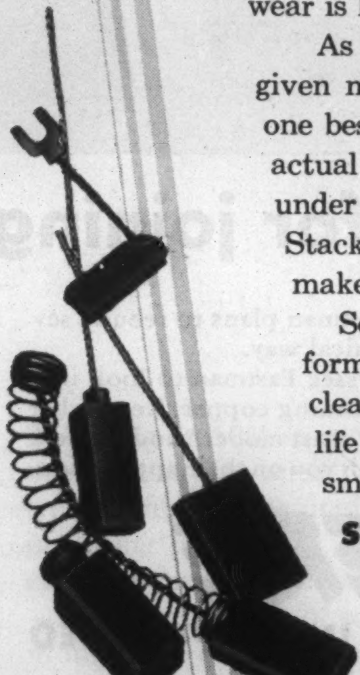

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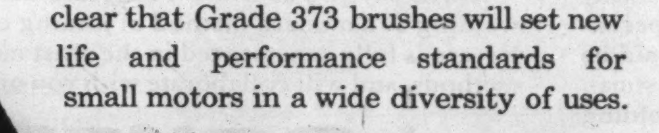
EQUAL (OR BETTER) PERFORMANCE THAN PREVIOUS GRADES



For more information, turn to Reader Service Card, Circle No. 383

able for cladding or cold-forming operations.

Bright annealing, which causes difficulty with large sections, can also be facilitated by the prior salt-bath treatment, which removes all traces of lubricant. Corrosion tests of samples descaled by the new method showed a slightly higher initial corrosion rate than pickled samples given the same annealing treatment. Life tests on two types of resistance wire indicated no significant difference between pickling in an acid bath and scale removal by the new chemical process.

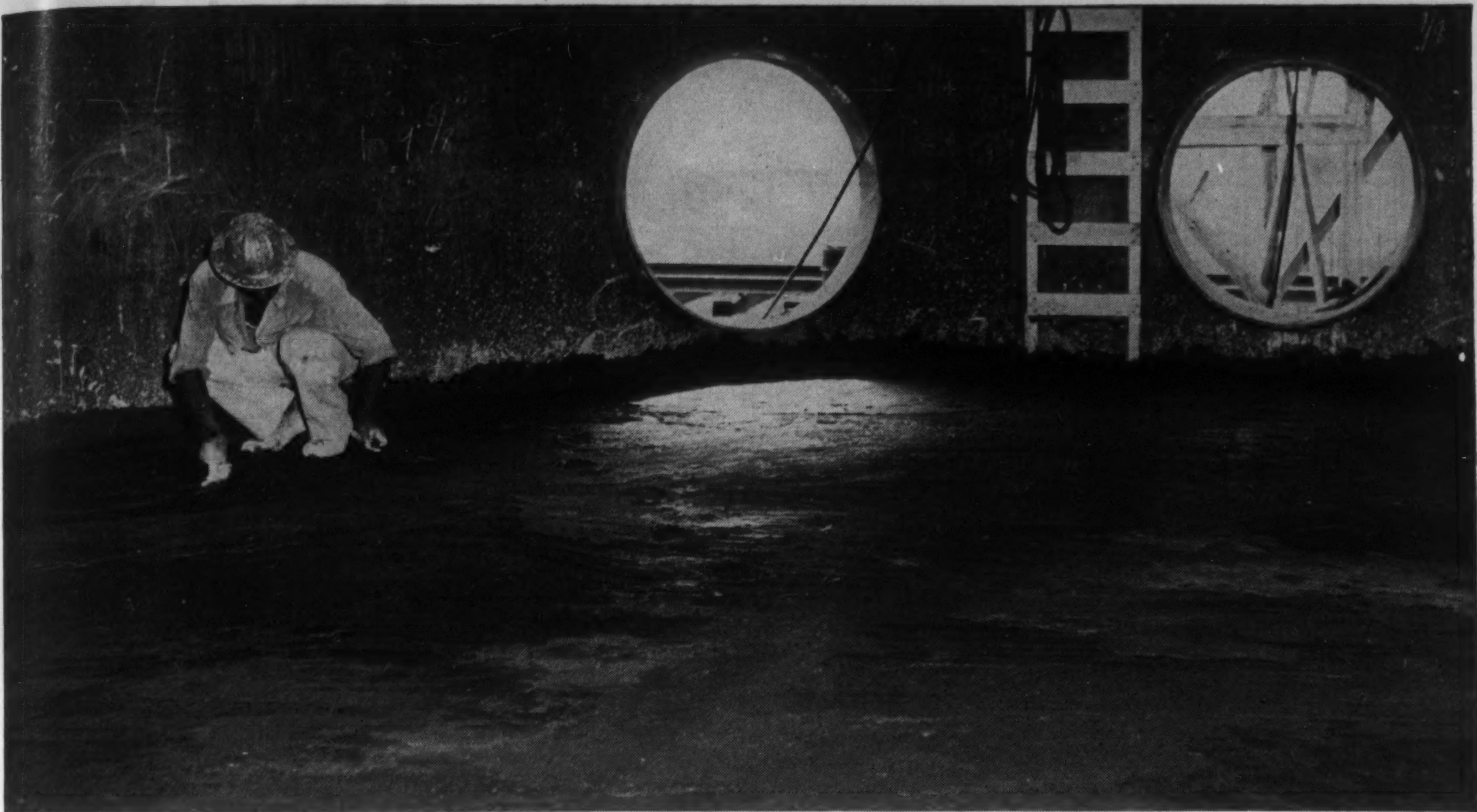
The new method has thus far been tried only on a laboratory scale and in the production of wire, but it should prove satisfactory for all other forms of high alloy steel. It can also be applied to some nonferrous alloys, such as copper-manganese-aluminum alloy. Cost of new continuous controlled-atmosphere furnaces needed for the process can be amortized over a short period by the resulting decrease in metal loss and the saving in acid-pickling costs.

Plastics on the Increase in German Cars

Though polyamides, such as nylon, were well known before World War II, they are just beginning to be used commercially in Germany, particularly in the automobile industry. Their commercial use has been slowed by difficulty in meeting the close tolerances demanded. This difficulty has evidently been overcome by cooperative work done by the plastics industry and the users, according to an article by H. Zickel in the March issue of *Werkstatt und Betrieb* (German). Mr. Zickel, in discussing some of the projected uses of polyamides in German cars, points out the particular properties of the materials making them suitable for specific applications.

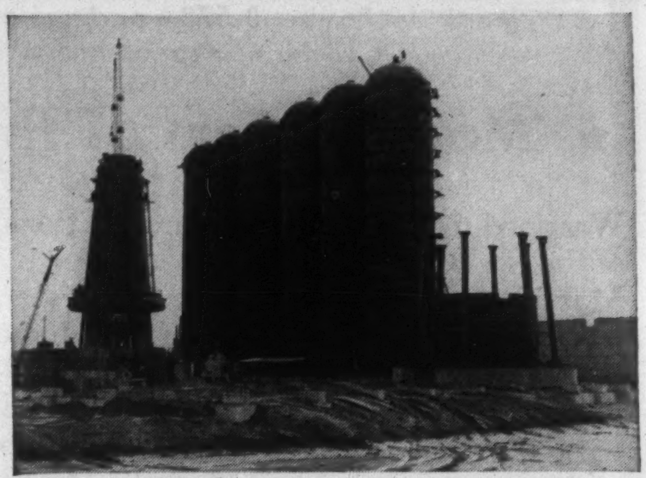
General properties

The adoption of polyamides is due mainly to their outstanding



HEAT-RESISTANT CONCRETE is easily placed in blast-furnace stove pads at Steel Corporation's Fairless Works, Morrisville, Pa. Industrial Concrete made with Atlas Lumnite cement speeds placement . . . reaches service strength within 24 hours!

Blast-furnace stove pads are easy to place with heat-resistant concrete



BLAST-FURNACE STOVES are only one example of the many ways that Industrial Concrete serves the metal industry. Industrial Concrete made with Atlas Lumnite cement gives long, trouble-free service . . . needs less maintenance.

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For added convenience you can use a Lumnite-base castable — packaged mixes of Lumnite cement plus aggregates selected for specific temperature and insulation needs. All *you* do is add water, mix and place. Castables are made and distributed by leading manufacturers of refractories.

You'll find Industrial Concrete made with Atlas Lumnite cement excellent for use wherever heat, corrosion or abrasion are problems. For more information, write Lumnite Bureau, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

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Photo courtesy Martin Aircraft

Martin Jet Bomber B-57B—package of engineering ingenuity wields new speed and mobility in this

★ Modern Arm of the Air Force ★

Wrapped up in this modern arm of the skyways is the wizardry of Martin engineers—masterminds who gave this fighting bomber a supremacy of visibility, mobility, speed and control.

In the success of this fighting craft, Continental takes modest pride in being selected to engineer and supply many of the molded and extruded rubber parts. A typical example is the cockpit seal which must not craze plexiglass and yet must remain flexible *even* at −70°!

Compounding and extruding rubber that will not craze plexiglass is a problem in itself. Producing rubber to remain flexible at −70° is still another. Furthermore, this part must have an exceptionally low compression set in order to retain its perfect seal. Resistance to every weather condition is *also* a must.

Producing a rubber part to meet all these critical specifications was a real challenge! Proper plasticizers had to be chosen, extensive laboratory tests conducted, and special handling was necessary to maintain the extremely close tolerances required. A challenge that Continental met and exceeded because of their 50 years' skill and experience in the specialized art of molding and extruding rubber.

The technical assistance offered for this part typifies the service available at Continental. When you need "engineered rubber parts," enlist the service of specialists—consult Continental.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

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physical and mechanical properties, especially their toughness, wear resistance, size stability at high temperatures, tensile strength, low specific weight (about 1/7 that of iron), nonflammability, low modulus of elasticity (good for noise damping), resistance to normal organic solvents and very low coefficient of friction. While parts are produced preferably by injection molding, they can also be machined from bars. The material can be metal-coated by vaporization or dyeing.

Gears and bearings

Polyamides are particularly suitable for gears because of their high impact strength, high wear resistance and ability to damp mechanical vibrations. Injection-molded gears can be used for instruments as well as for other gears which are not subjected to high temperatures. Unlike other plastics, polyamide gears give excellent results running against other polyamide gears. Lubrication is not absolutely essential but improves operating characteristics as well as gear life.

Their frictional characteristics make polyamides suitable bearings where lubrication is difficult or impossible. They have good embeddability, but the design must be such as to compensate for low thermal conductivity. Among such applications are bushings and plates in steering mechanisms. In contrast to presently used phenol plastics, polyamide parts can be made thinner and less expensively and do not need lubrication. Other possible applications include spacers for leaf springs, door hinges and locks, shock absorbers, cages for roller and ball bearings and water pump parts.

The author points out that since polyamides can be given a finish resembling chromium, they might be used in hub caps. At least the metal caps could be seated in a polyamide ring to give a squeak-free connection. An-

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CONTROLLED STRENGTH

GIVE TOOLS THE BEST PROTECTION WITH THE LEAST AMOUNT OF TAPE

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The mill cutter you see in the photograph has a tough sheath of *Polyken* Tape that protects the sharpened edges of the tool. This sheath conforms to the irregular shape of the cutter, provides abrasion resistance, and pulls off clean when the tool is used. But with paper tape, you'd have to use at least twice as much. Even then, you'd merely be covering the cutter, not really protecting it.

Polyken Tapes have the *controlled strength* to do this job without waste. That controlled strength is produced by combining the right pressure-sensitive adhesive with a cloth backing. Cloth—because cloth backing has much greater abrasion resistance and almost twice the tensile strength of an equal width and length of paper backing.

Use *Polyken* controlled strength Tapes to cut your tape costs. Send in the coupon for complete information.

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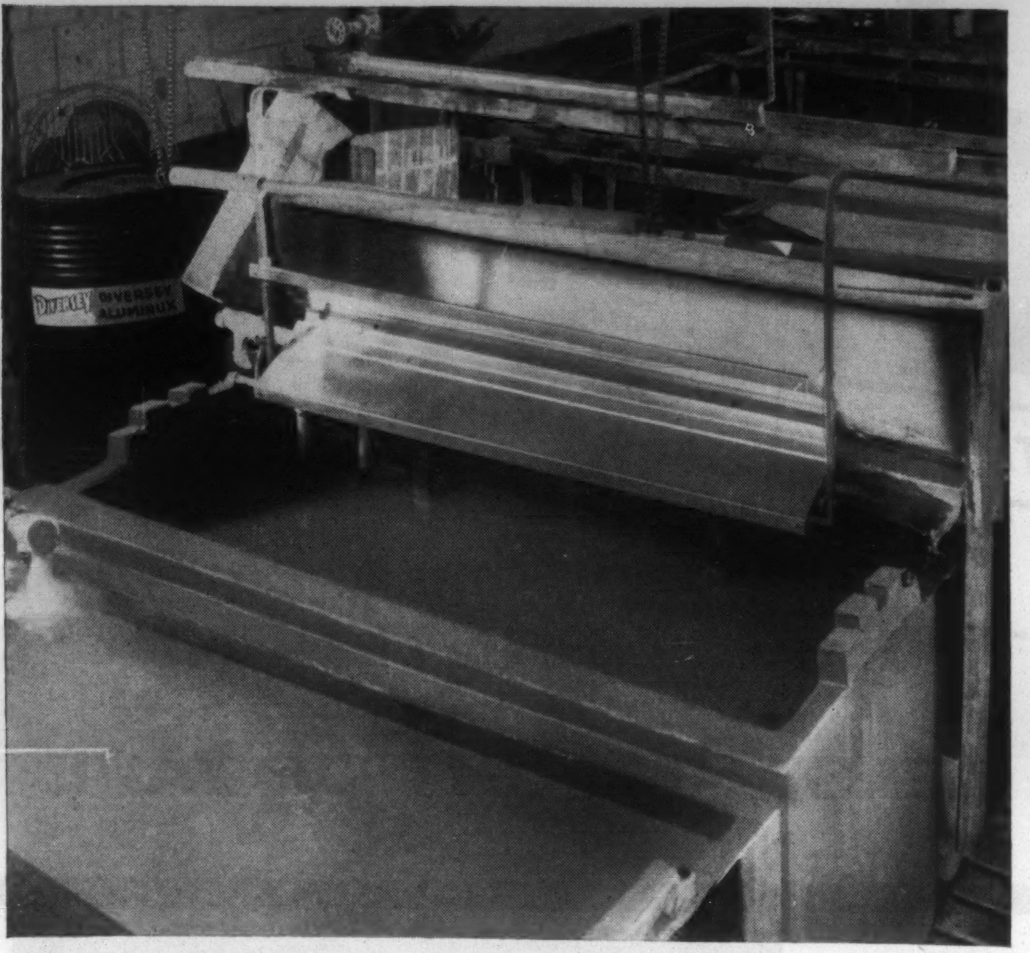

Advanced Aluminum Etching Process

During the past few years considerable research has been done on the problem of bringing out the natural sales appeal of aluminum. However, it wasn't until The Diversey Corporation perfected Aluminux that an alkaline etching compound for all aluminum alloys was found that produced a uniform, top quality etch in shorter etching cycles without forming sludge and scale.

The need for an evenly etched surface with diffused reflectance is probably more evident in the architectural finishing field than any other single industry. The exteriors of many modern buildings are almost entirely aluminum . . . aluminum panels, aluminum window frames, aluminum doors. A uniformly etched, attractive surface is imperative if the building is to have the beauty the architect showed on his drawing board. One product . . . Aluminux . . . has emerged as the etchant best meeting these high requirements.

With Aluminux, a finer, more even appearing etch is produced. Aluminux reacts with the aluminum surface uniformly and rapidly, eliminating die and tool marks. The degree of etch is easily controlled by varying the concentration, the time of etching or the temperature.

Etching with Aluminux assures a satin, bright surface prior to anodizing, conversion coating, painting or lacquering. For more information write to The Diversey Corporation . . . 1820 Roscoe Street . . . Chicago 13, Illinois.

For more information, turn to Reader Service Card, Circle No. 418

Contents Noted

other use for polyamides in automotive production is the substitution of polyamide sheet for paper in the production of two-color bodies. Since polyamides are not attacked by solvents, the sheet could be used again and again.

Books . . .

Plastics Tooling. *Malcolm W. Riley. Reinhold Publishing Corp., New York 22, N. Y. Cloth 5 by 7 in. 123 pp. Price $2.50.*

Plastics have been used as tool materials for only a brief period and little data have been published dealing with this application. "Plastics Tooling" is the first book to summarize the available information on a technique which is widely used in the aircraft industry but has had only limited application in the general industrial field.

The book is divided into 10 chapters covering the reasons for selecting plastics for tools, the resins used for the purpose, methods of producing the tools and applications. A brief bibliography is included.

Engineers, die designers and production executives concerned with the production of stamped and drawn parts will be particularly interested in reading this book.

Aluminum Paint and Powder. *Junius D. Edwards and Robert I. Wray. Reinhold Publishing Corp., New York 22, N. Y. Cloth 6 by 9 in. 219 pp. Price $4.50.*

The third edition of this book has been completely revised to present the latest information in the field. Approximately one third of the book is devoted to a discussion of the manufacture of aluminum powders, the properties and testing of the powders and paste and the composition of aluminum paint. The rest of the book discusses applications. Chapters deal with the uses of aluminum paint in the protection of metals and wood, and in miscel-

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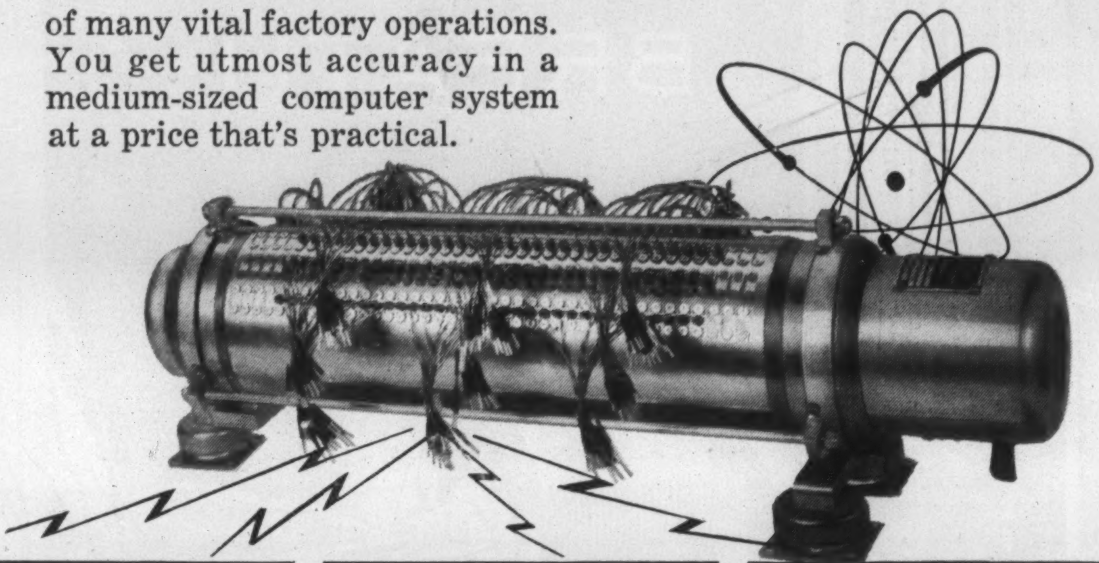

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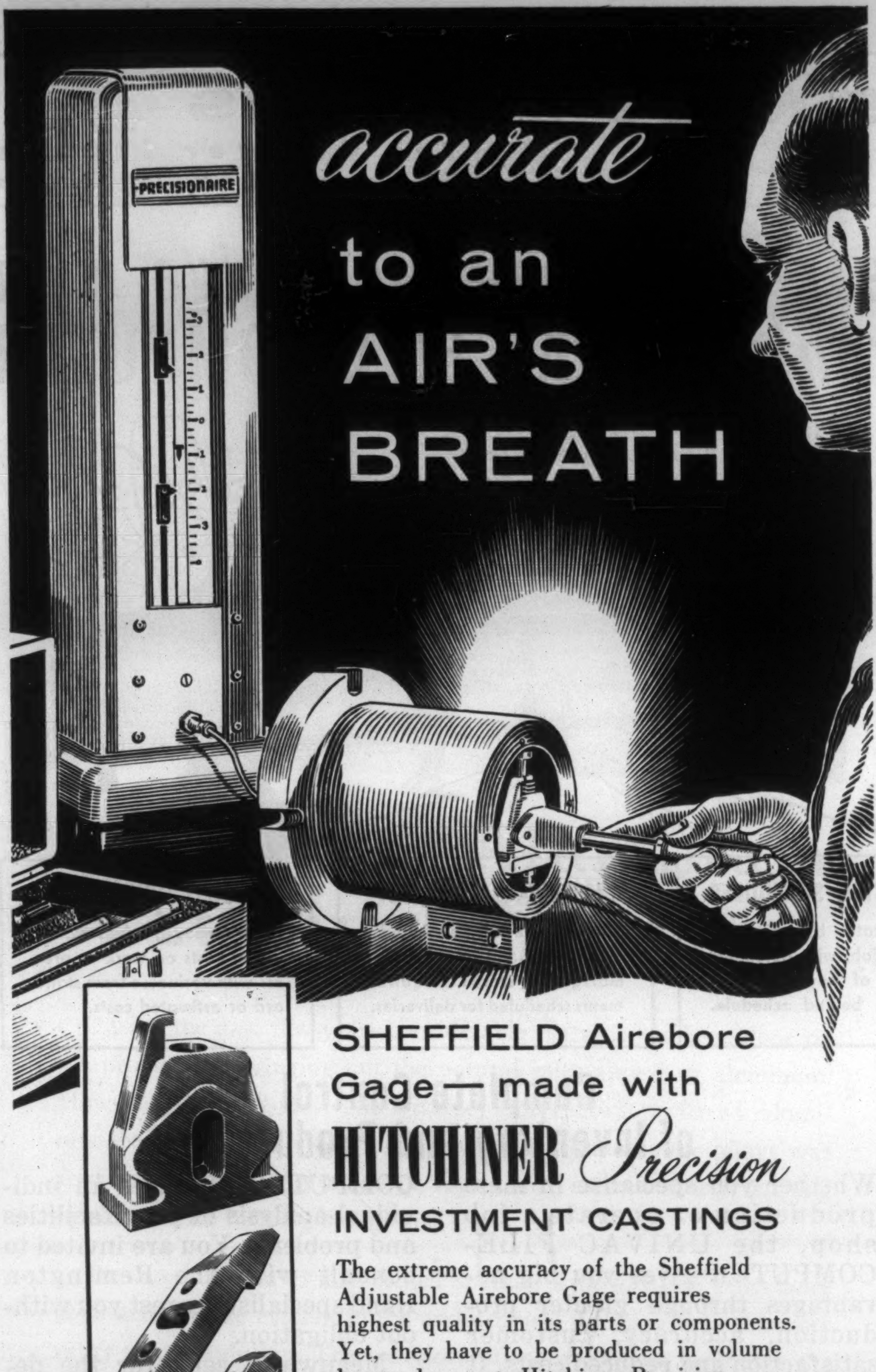

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Contents Noted

Books . . .

laneous applications based on such properties as thermal conductivity, reflectance and visibility. Although a major part of the book deals with aluminum paint, there are other applications which consume a substantial portion of the aluminum powder production. A chapter is devoted to a discussion of applications in powder metallurgy, metallized paper, explosives, and plastics.

Dimensions and Tolerances for Mass Production. *Earle Buckingham. The Industrial Press, New York 13, N. Y. Cloth 8½ by 11 in. 164 pp. Price $8.00.*

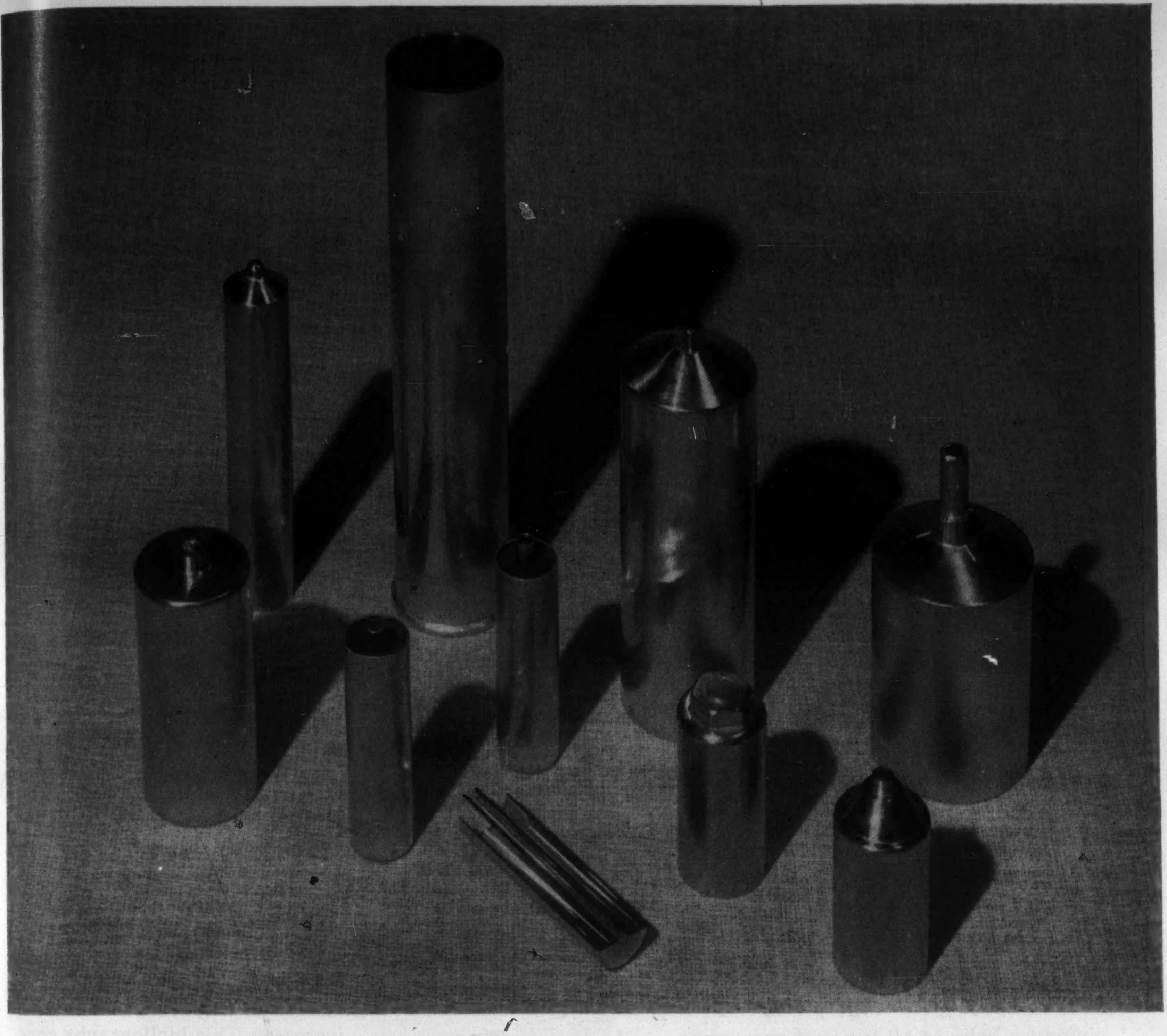
In this book the author presents a practical approach to the problem of dimensioning with tolerances in relation to production design, tool design, gage design, production and inspection. Methods and practices which eliminate many of the uncertainties of present-day practice are suggested. Numerous illustrations show how improved methods can be the key to lower cost production.

ASTM Standards on Electrical Insulating Materials. *American Society for Testing Materials, Philadelphia 3, Pa. Paper 6 by 9 in. 660 pp. Price $5.50.*

This compilation includes the latest ASTM methods of testing and specification. It contains 60 testing methods, 17 specifications, 3 recommended practices and a list of definitions. Thirty-three of the designations are either new or have been revised since the last edition of the compilation was issued in 1953.

Electrons, Atoms, Metals and Alloys. *William Hume-Rothery. Philosophical Library, New York 16, N. Y. Cloth 6 by 9 in. 387 pp. Price $10.00.*

This is a revised reprint of the book published originally in 1948. The text is presented in the form of a dialogue between an older metallurgist and a young scientist. By the use of this device, the



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Contents Noted

Books . . .

author brings out clearly the difference between the old and new viewpoints. Many difficulties are discussed and the dialogue is framed to give the reader continued help in understanding the problems at issue.

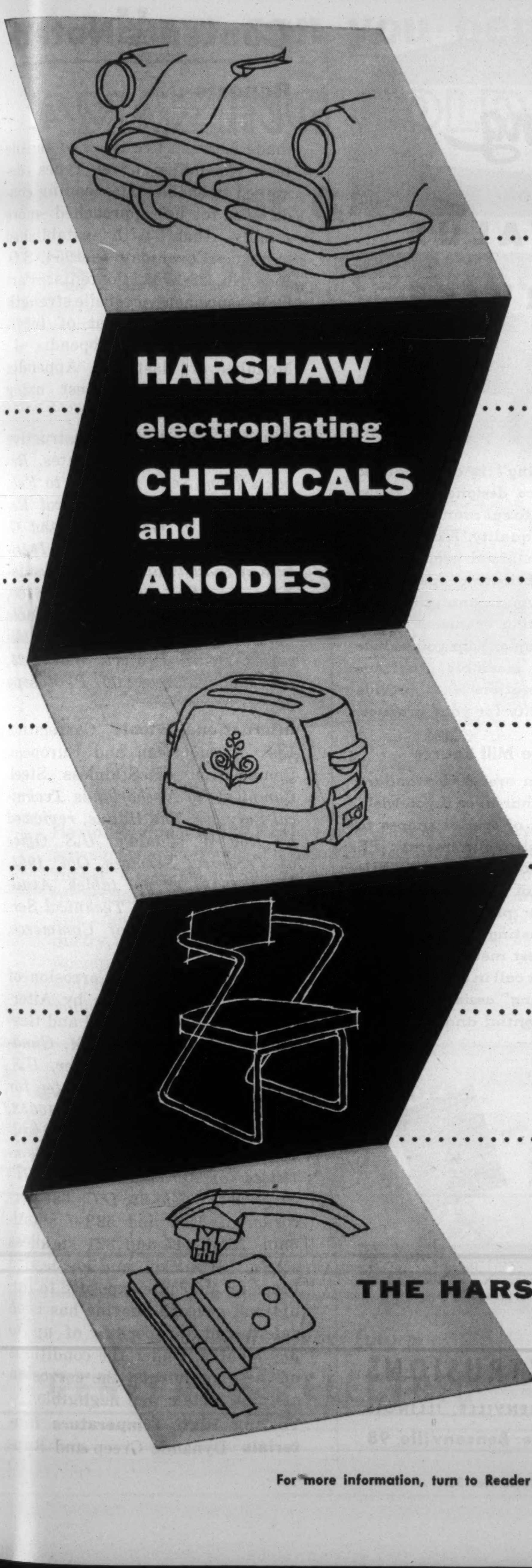
Although this book was written primarily for the metallurgist, it will prove valuable to many engineers in other fields as an elementary introduction to modern atomic theory. For students, it should serve as a relatively easy introduction to the formal treatment of the subject in standard texts.

Abstracts of the Literature on Semiconducting and Luminescent Materials and Their Applications. *Compiled by Battelle Memorial Institute. Sponsored by Electrochemical Society, Inc. Published by John Wiley & Sons, New York, N.Y., 1955. Paper bound, 9 by 11½ in. 169 pp. Price $5.00.*

The need for a bibliography on semiconducting and luminescent materials and their applications has been recognized as the amount of literature in this field increased. This bibliography covers literature published from Jan. 1 through Dec. 31, 1953. The principal source of reference has been the abstract journals, although, where possible, the entire publication has been reviewed. Subject and author indexes are included to facilitate finding the material. Papers read at various societies, though not yet published, are included.

Reports . . .

Plastics Testing Methods of Testing Reinforced Plastics, Parts I and II. *F. T. Barwell, Great Britain, Ministry of Supply, Aeronautical Research Council, Apr. 1948. PB 116061, 34 pp, photographs, drawings, diagrams, tables. Available from British Information Services, 30 Rockefeller Plaza, New York 20, N.Y. $2.25.* An experimental comparison has been



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Contents Noted

Reports . . .

made between five types of tensile tests including novel types designed to enable axial loading conditions to be approached more readily than with established methods. Cover date is 1954. S.O. code No. 23-2702. Contents: Part I: Measurement of tensile strength Part II: Measurement of interlaminar strength. Appendix I: Modulus of elasticity. Appendix II: Cross Breaking test using German apparatus.

Testing Wood Non-Destructive Testing of Wood Laminates. *Reports from Sept. 28, 1953 to Feb. 28, 1954 to Office of Naval Research. S. V. Galginaitis and G. Gazo, Louisville University, Institute of Industrial Research, Louisville, Ky., Feb. 1954. PB 116100, 16 pp, graphs, tables. Available from Library of Congress, Publication Board Project, Wash. 25, D. C. Microfilm $2.00, Photocopy $2.75*

International Steels Correlation List of American and European Composition of Stainless Steel. *Compiled by Netherlands Technical Services, The Hague, reviewed by Roy W. Tindula, U.S. Office of Technical Services, Oct. 1954. PB 111549, 12 pp, tables. Available from Office of Technical Services, U.S. Dept. of Commerce, Wash. 25, D.C. $.50.*

Fluorine Corrosion Corrosion of Metals of Construction by Alternate Exposure to Liquid and Gaseous Fluorine. *Richard M. Gundzik and Charles E. Feiler, U.S. National Advisory Committee for Aeronautics, Dec. 1954. PB 116053, 10 pp, photographs, tables. Available from National Advisory Committee for Aeronautics, 1512 "H" St., N.W., Wash. 25, D.C.* The corrosion of 3S-0 and 52S-0 aluminum, AISI 347 and 321 stainless steels, "A" nickel, and low-leaded brass by alternate exposure to liquid and gaseous fluorine has been determined for periods of up to 3½ months. Under the conditions of the experiments, the corrosion of these metals was negligible.

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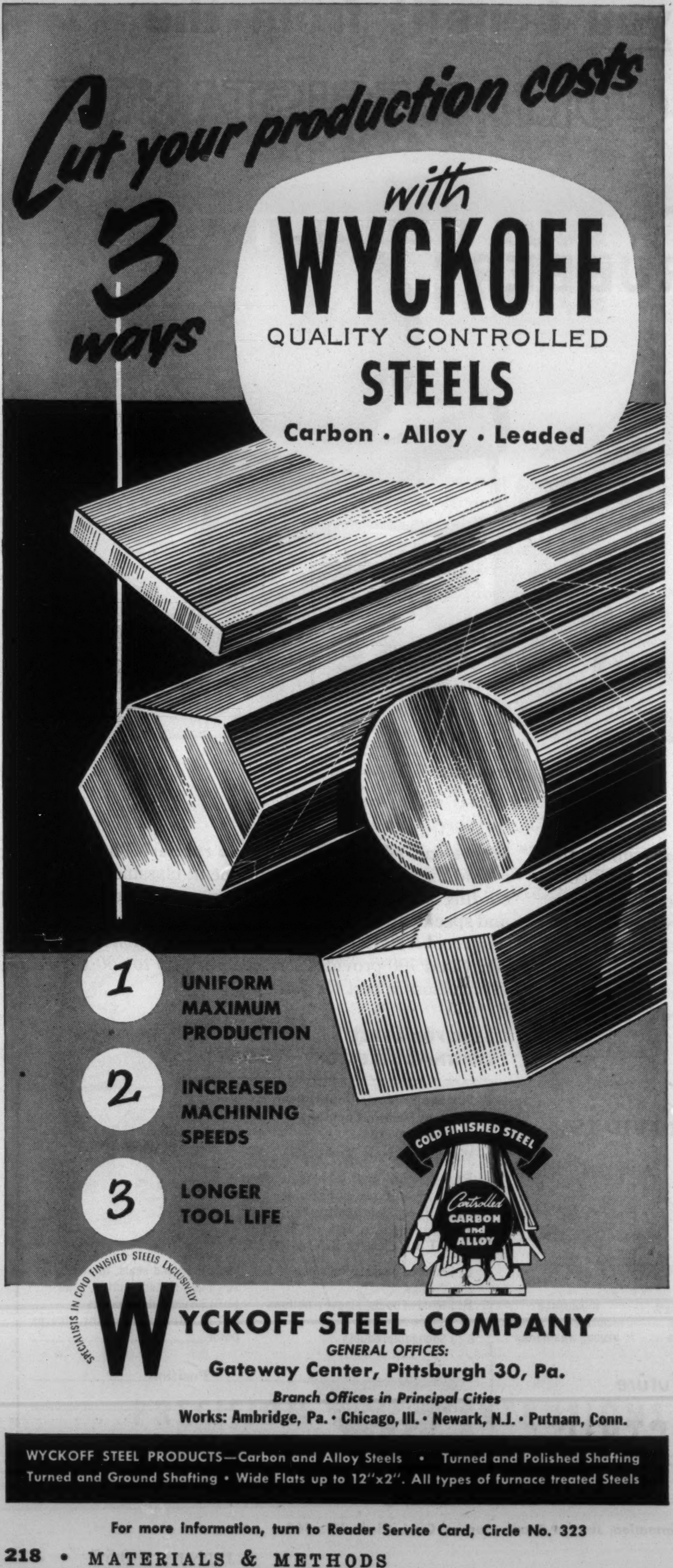

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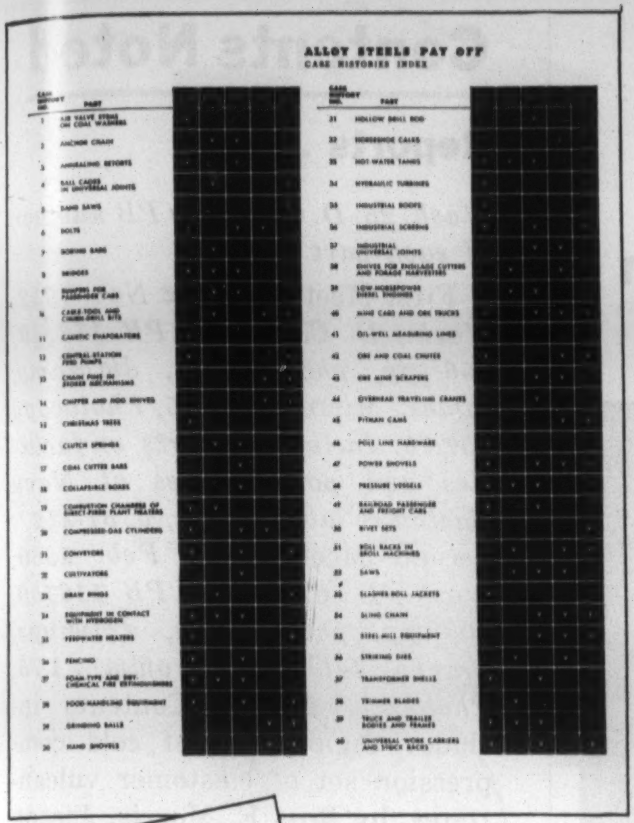
Reports . . .

ture Properties of Temperature Resistant Materials Under Tensile Fatigue Stress. *Syracuse University, Dept. of Materials Engineering, Syracuse, N.Y., Nov. 1949. PB 116167, 42 pp, photographs, drawings, graphs, tables. Available from Library of Congress, Publication Board Project, Wash. 25, D.C. Microfilm $2.75, Photocopy $6.50.* Newly developed dynamic testing machines and measuring equipment for determining creep and rupture properties are described. Data on several temperature-resistant materials are presented within mean stress alternating stress coordinates to show the influence of dynamic stress on creep and time to rupture. The relationships between testing temperature and dynamic stress influence on creep and rupture are shown. The increased creep and rupture resistance during some of the dynamic tests is discussed in terms of possible metallurgical changes caused by cyclic stress. Cover date is Feb. 1950. Contract W33-038-ac-15941 (17507).

Analysis of Titanium Spectrochemical Analysis of Titanium Metal and Alloys. *Interim Report No. 3 under Contract No. DA-018-ORD-11511. J. H. Enns, Michigan University, Engineering Research Institute, Ann Arbor, Mich. Aug. 1953. PB 116209, 36 pp, graphs, tables. Available from Library of Congress, Publication Board Project, Wash. 25, D.C. Microfilm $2.50, Photocopy $5.25.* The porous-cup-solution technique described previously in the Interim Technical Report No. 2 for the analysis of Fe and Cr in titanium alloys has been extended to include Al and Mn. Project M973. ORD TB 1-12045-2. For Reports No. 1-2 see PB 108884-108885.

Elastomer Development Proceedings of the Navy Conference on Elastomer Research and Development. *U. S. Office of Naval Research. Order separate parts as described below from Library of Congress, Publication Board Project,*



ALLOY STEELS PAY OFF
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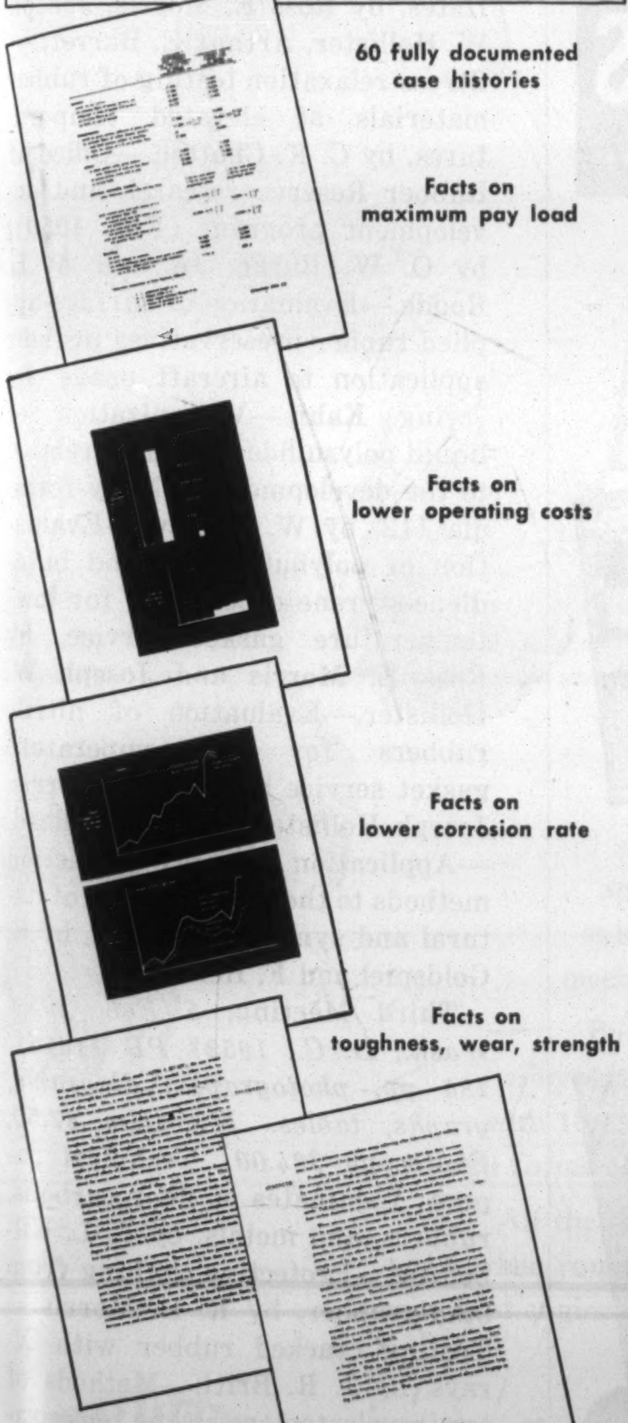

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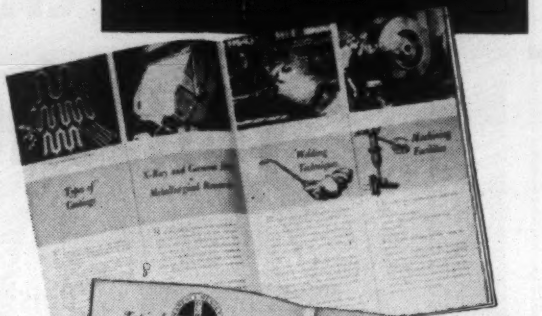

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Contents Noted

Reports . . .

Wash. 25, D. C., giving PB number of each part ordered.

First Meeting, *1 & 2 Nov. 1949, Wash., D. C., 1949? PB 116149, 456 pp, photographs, diagrams, tables. Microfilm $9.25, Photocopy $57.75. Includes Reports on facilities and potentialities at Navy elastomer laboratories, p. 51-442.*

Second Meeting, *15 Feb. 1950, Wash., D. C., 1950? PB 116150, 109 pp, photographs, drawings, graphs, tables. Microfilm $4.75, Photocopy $14.00.* Contents include: Significance of cold compression set of elastomer vulcanizates, by Ross E. Morris, Joseph W. Hollister, Arthur E. Barrett.—Stress-relaxation testing of rubber materials at elevated temperatures, by C. K. Chatten.—Office of Rubber Reserve research and development program (Feb. 1950), by O. W. Burke, Jr. and A. L. Rodde.—Evaluation of surface-applied rubber preservatives in their application to aircraft usage, by Irving Kahn.—Vulcanization of liquid polysulfide rubber as related to the development of Navy formula 112, by W. B. Lew.—Evaluation of polybutadienes and butadiene-styrene copolymers for low-temperature gasket service, by Ross E. Morris and Joseph W. Hollister.—Evaluation of nitrile rubbers for high-temperature gasket service by Ross E. Morris, Joseph Hollister, Paul A. Mallard.—Application of X-ray diffraction methods to the identification of natural and synthetic rubbers, by S. Goldspiel and F. Bernstein.

Third Meeting, *5 Feb. 1952, Wash., D. C., 1952? PB 116151, 186 pp, photographs, diagrams, graphs, tables. Microfilm $7.50, Photocopy $24.00.* Technical papers: Laminates of fluorocarbons, rubbers, and metals, by F. L. Kilbourne.—Protective clothing from butyl rubber, by R. E. Morris.—Testing cracked rubber with X-rays, by J. R. Britt.—Methods of testing elastomers at low temperatures, by J. Z. Lichtman.

Synthetic Rubber Synthetic Rubbers from Carbonfluorine Compounds. *Minnesota Mining and*

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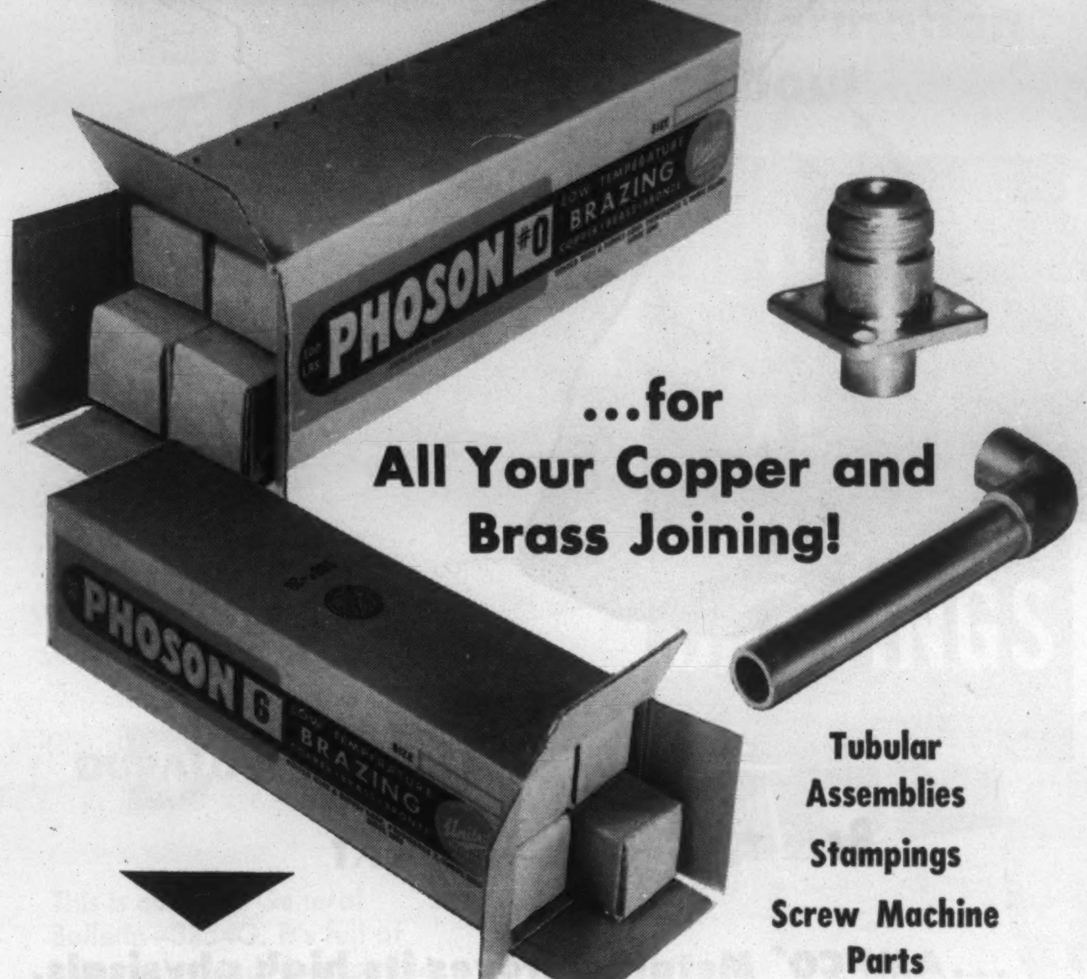

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Highly Efficient! Most Economical!

Use Phoson-O for brazing joints of consistently uniform clearances — quickly, safely, surely!

PHOSON-6 (6% Silver)

For really low temperature brazing and complete control of alloy flow . . . where maximum ductility and varying joint tolerances are key factors.

PHOSON-O (No Silver!) PHOSON-6 (6% Silver)

These Two Alloys For All Your Copper and Brass Joining!

Two Good Reasons Why PHOSON BRAZING ALLOYS Are Busier Than Any Brazing Alloys In The Country!

Wherever Metals Are Joined, Keep Them — Permanently United

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Brazing Alloy Division
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Contents Noted

Reports . . .

Manufacturing Co., St. Paul, Minn. Contract AF 33(038)-515. Order separate parts as described below from Library of Congress, Publication Board Project, Wash. 25, D. C., giving PB number of each part ordered.

Part 1, *by W. H. Pearlson and N. W. Taylor, Oct. 1952. PB 116221, 120 pp, graphs, tables. Microfilm $5.00, Photocopy $15.25.* New polymeric compositions of matter have been synthesized and screened with respect to their potentialities as suitable elastomers for use under extreme conditions of temperature in contact with various fuels and oils. Sec. 1 is report for contract period 15 May 1949 to 15 May 1950; Sec. II is for period 15 May 1950 to 15 May 1951.

Part 2, *By A. M. Borders, Aug. 1952. PB 116222, 115 pp, graphs, tables. Microfilm $5.00, Photocopy $15.25.* New classes of materials include polymers of unsaturated and perfluoroalkyl esters, fluorine-containing alkoxyalkyl acrylates, and vinyl 1, 1-dihydroperfluoroalkyl ethers, and copolymers of perfluortoacrylonitrile, and of perfluorobutadiene. Polymers and copolymers of 1, 1-dihydroperfluoroalkyl acrylates continue to exhibit the best balance of low temperature flexibility and resistance to aromatic hydrocarbon fluids. Although reinforcement of the fluoroacrylate homopolymers has not been possible their butadiene copolymers have been reinforced to vulcanizates with tensile strengths in excess of 2000 psi. Third annual report, covering period 15 May 1951 to 15 May 1952.

Part 3 *By F. A. Bovey, Sept. 1953. PB 116223, 205 pp. Microfilm $7.75, Photocopy $26.50.* The object of the work is the development of elastomeric materials which are resistant to the fuels, lubricants, and hydraulic fluids used in military aircraft, and which are serviceable over the widest possible temperature range. Perfluorobutadiene copolymers and fluoroacrylates were of primary interest. Fourth annual report.

OLSEN Puts a
Reverse Twist
in Torsion Testing

Torsion testing is not just one, but both directions—*continuously* and with *only one set of grips* . . . and that's only part of the trend setting story about the Double Torsion Testing Machine—a Tinius Olsen Exclusive.

This Olsen torsion machine applies a twist of "X" degrees in one direction of rotation and indicates the load on the SelecTrange dial. With the flip of a switch, the machine reverses, applies and indicates any desired twisting load in the opposite direction. At the same time a permanent record of all phases of the test can be made in BOTH directions of rotation with an Olsen Electrical Torsion Recorder.

This amazing torsion machine with its double weighing system is made possible by the Olsen SelecTrange electronic indicating system. The applied load is read directly in inch-pounds on the large 28-inch illuminated dial. Full dial scale is available for each capacity range in both clockwise and counter-clockwise rotations. These features, coupled with unmatched ease of operation, and guaranteed accuracy are a few of the many reasons why your first and best choice for torsion testing is an Olsen Double Torsion Testing Machine.

Write for further information

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1955

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Testing & Balancing Machines

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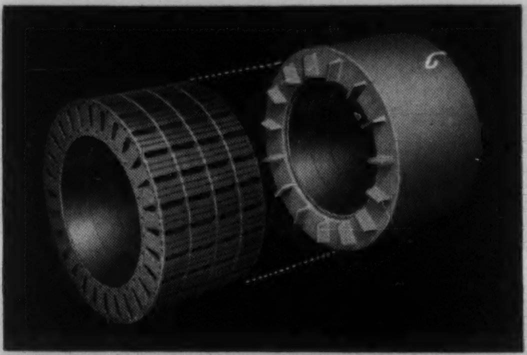
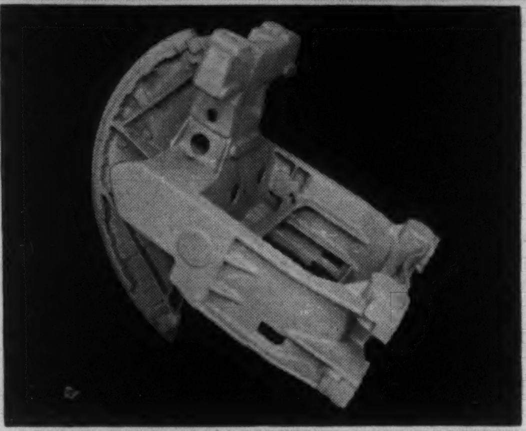


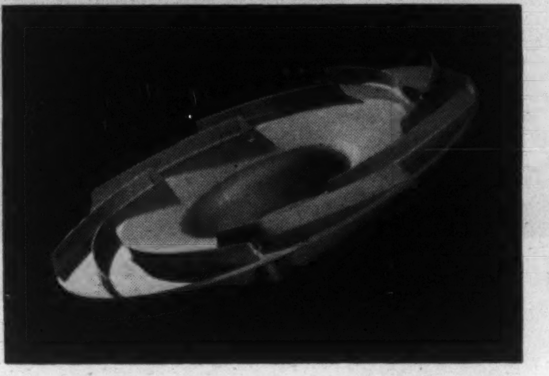
MAGNETIC OUTPUT BOOSTED 10% BY ROLLE MFG. CO.

Rolle advanced casting techniques keep permanent magnet insert temperatures down, yet assure a sound permanent mold aluminum casting. As a result, magnetic output of this alternator rotor is up 10% over best previous attempts.



NIGHTMARE SPECIFICATIONS MET BY ROLLE MFG. CO.

Complicated internal structure, unequal wall sections, complex wall joinings, intricate internal webbing, make feeding and chilling stressed areas a nightmare in this sand casting. But Rolle Manufacturing is turning out castings able to pass 100% X-ray examination to highest aircraft standards in production quantities.



CASTING COSTS CUT 44.5% BY ROLLE MFG. CO.

Rolle recommended change from sand casting to permanent mold casting of this part, with guaranteed surface in required areas, between fins, of from 100 to 125 microinches. Change resulted in casting costs down 44.5%, and machining time cut in half.

ROLLE CAN SOLVE YOUR CASTING PROBLEMS

Your casting problems—sand or permanent mold, aluminum or magnesium alloys—can always be solved quickly and economically if you bring them to Rolle. But the advantages of fighting weight with strength with Rolle don't stop there. Some of the most impressive savings Rolle has made for customers involved castings that were never considered "problems."

You can get some idea, just from the few cases illustrated here, of how the use of advanced techniques . . . a change in casting method . . . variation in any of a hundred casting considerations, can bring immediate returns in either reduced costs or improved performance, or both.

Write now for a free booklet that tells how you can solve casting problems with Rolle.

FIGHT WEIGHT WITH STRENGTH with ROLLE

MANUFACTURING COMPANY

303 Cannon Avenue Lansdale, Penna.

For more information, turn to Reader Service Card, Circle No. 429

news of ENGINEERS COMPANIES SOCIETIES

NEWS OF ENGINEERS

Robert S. Stevenson has been elected president, Allis-Chalmers Manufacturing Co.

John F. Haines has joined Alco Products, Inc. as chief development engineer, atomic products.

General Walter Bedell Smith has been named chairman of the board and president, AMF Atomics, Inc., a newly-formed subsidiary of American Machine & Foundry Co.

James F. Healey has been appointed to the technical staff, Aro Equipment Corp.

Paul R. Grossman has been made director of research, the Babcock & Wilcox Co.

Loran S. O'Bannon and **Dr. Hamnett P. Munger** have been named technical advisers, Battelle Memorial Institute.

Gordon A. Sommer has been made head of a new department for research into new techniques of pressworking metals, and development of equipment for improved efficiency in metalforming, Clearing Machine Corp.

Norman L. Deuble has been appointed manager of a newly-created Metallurgical Development Div., Climax Molybdenum Co.

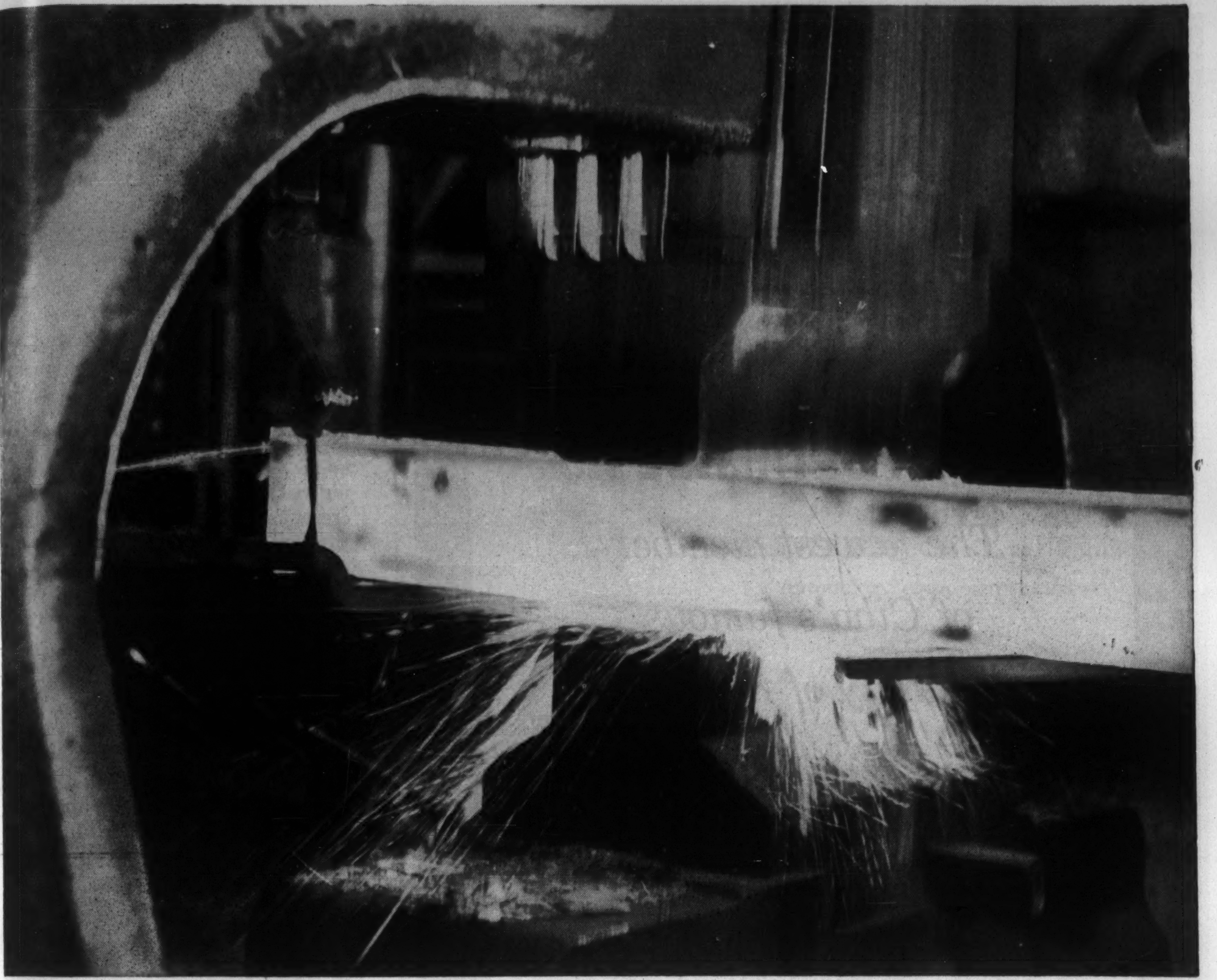
Dr. Charles L. Critchfield has been named director of scientific research, Convair Div., General Dynamics Corp.

George L. Tillson, formerly president, Edgcomb Steel and Aluminum Corp., has been elevated to chairman of the board and chief executive officer of the company.

Douglas A. Hopper has been named general manager of General Electric Co.'s Welding Department, and **Richard A. Schaus,** manager of induction and miscellaneous equipment engineering for the company's Industrial Heating Department.

Charles B. Sanborn has joined the Electroplating Section, Development and Research Div., the International Nickel Co., Inc.

Leo J. Jacobson has been appointed chief engineer, International Resistance Co. Other appointments by the company include **George Williams** as group leader, product engineer-



From Vacuum Melting – improved alloys with exceptional properties

...higher **IMPACT RESISTANCE,** *for example*

Here's another important advantage of vacuum-melted alloys – *substantially higher impact resistance* . . . over 25 times greater, for example, in one grade of stainless steel.

Tensile strength, stress rupture strength at elevated temperatures, fatigue life, ductility, uniformity, and fabricating characteristics are improved, too, by vacuum-melting.

Here's why . . . *Vacuum-melting literally sucks gaseous impurities from the molten metal . . . removes inclusions and gases that limit the performance of conventional air-melted alloys. That means purer metals that are stronger, tougher . . . closer to their theoretical limits of properties.*

Vacuum Metals Corporation, pioneer in development and leading producer of vacuum-melted metals, now can promptly supply them in tool, high-speed, stainless, and alloy steels – in most sizes and grades – as well as special ferrous and nonferrous alloys. For help with metal problems that vacuum-melted alloys might solve, please write us, describing them in as much detail as possible. *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, N. Y.*

VMC

VACUUM METALS CORPORATION

Jointly owned by Crucible Steel Company of America and National Research Corporation

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Hear This!

ANNOUNCING

G.M.I. POLYAMIDE 115

The newest member of Ciba's famous family of resins for industry

Polyamide 115 and Epoxy Resins chemically combine to enable you to reach out toward new and better product design and to achieve lower production costs.

Flexibility, high impact values and good adhesion, are the direct result you can expect with this efficient combination.

Send for new Technical Bulletin No. 8...

"G.M.I. POLYAMIDE 115 AND ARALDITE EPOXY RESINS."

PLASTICS DIVISION
Ciba Company Inc.
627 Greenwich Street
New York 14, N.Y.

CIBA

ARALDITE® Epoxies

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news of ENGINEERS

ing; **Benjamin F. Gerding,** manager, manufacturing engineering; and **Carl Smith,** manager, quality control.

George J. Hutzler has been made manager of engineering research, Spencer Kellogg and Sons, Inc.

L. K. Stringham has been appointed vice president in charge of engineering, the Lincoln Electric Co.

Benjamin S. Collins has been named chief development engineer, Plastics Div., Nopco Chemical Co.

Ray Gayner has assumed his duties as new assistant to the manufacturing vice president, Northrop Aircraft, Inc.

Nils G. Andersson has been made manager of the Engineering Products Div. at Radio Corp. of America's Camden, N. J., manufacturing plant.

Durwood J. Hedgecock has been appointed chief engineer, Reynolds Metals Co.

Edwin R. Broden has been elected executive vice president, SKF Industries, Inc.

Edmond Sherman has been appointed chief engineer, Transitron, Inc.

Stephen T. Moreland has been engaged by Turner Brothers, Inc., as director of engineering.

news of COMPANIES

Aeroquip Corp. has acquired **Marman Products, Inc., Los Angeles.**

American Locomotive Co. has changed its name to Alco Products, Inc.

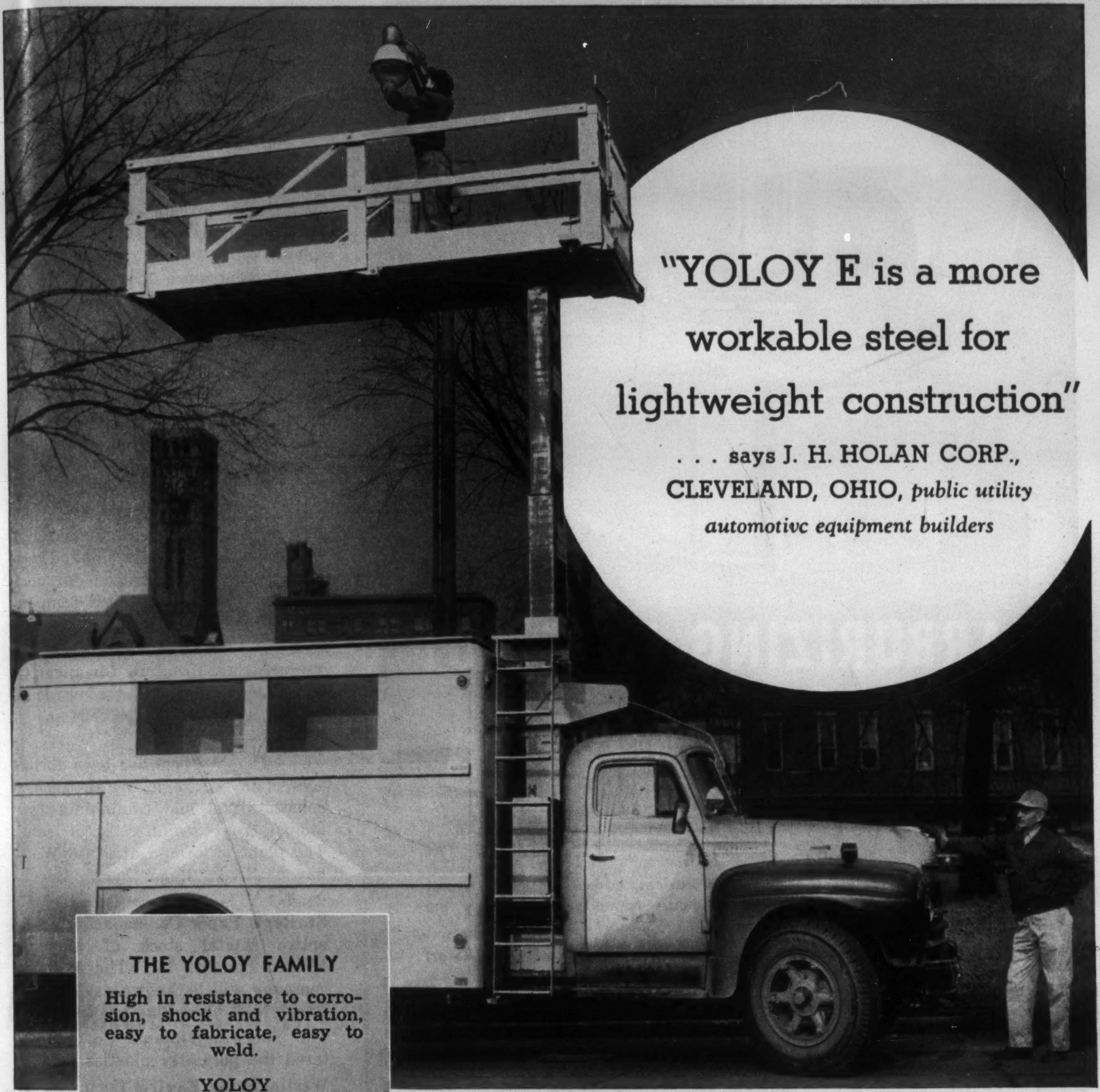
Allied Products Corp. has completed a new stamping plant at Eaton Rapids, Mich., for its Richard Brothers Div.

The American Brass Co. has announced plans to construct a $13,000,000 brass mill in Los Angeles County, Calif.

Anocut Engineering Co. has announced its formation for the development and manufacture of equipment for automatic electronic control of electrolytic shaping systems. The company maintains laboratory and manufacturing facilities at 631 W. Washington Blvd., Chicago.

Austenal Laboratories' Microcast Div. has made plans to expand production facilities at its New Jersey plant with construction of a new building.

Columbia-Southern Chemical Corp. has begun construction of a multi-



"YOLOY E is a more workable steel for lightweight construction"

. . . says J. H. HOLAN CORP., CLEVELAND, OHIO, *public utility automotivc equipment builders*

THE YOLOY FAMILY

High in resistance to corrosion, shock and vibration, easy to fabricate, easy to weld.

YOLOY
(Nickel-Copper)
Low Alloy High Strength Steel

YOLOY E
(Nickel-Chrome-Copper)
Low Alloy High Strength Steel

YOLOY C
(Chrome-Copper)
Corrosion Resistant Steel

Holan-built utility truck body fabricated from Yoloy E steel.

● This utility body builder finds Yoloy E—Youngstown's low-alloy high-strength steel—an important time-and-money saver and product improver.

They report that Yoloy E is an easily "workable" steel. Once brake dies are set, there is remarkably little breakage and scrap.

Truck users also benefit. The high strength of Yoloy E permits the use of lighter gauge in bodies and equipment, providing reduced weight and increased payload. The exceptional rust-and-corrosion-resistance lengthens equipment life, reduces maintenance.

For information about Yoloy steels, write our nearest District Sales Office.

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Manufacturers of Carbon, Alloy and Yoloy Steel

General Offices: Youngstown, Ohio - District Sales Offices in Principal Cities

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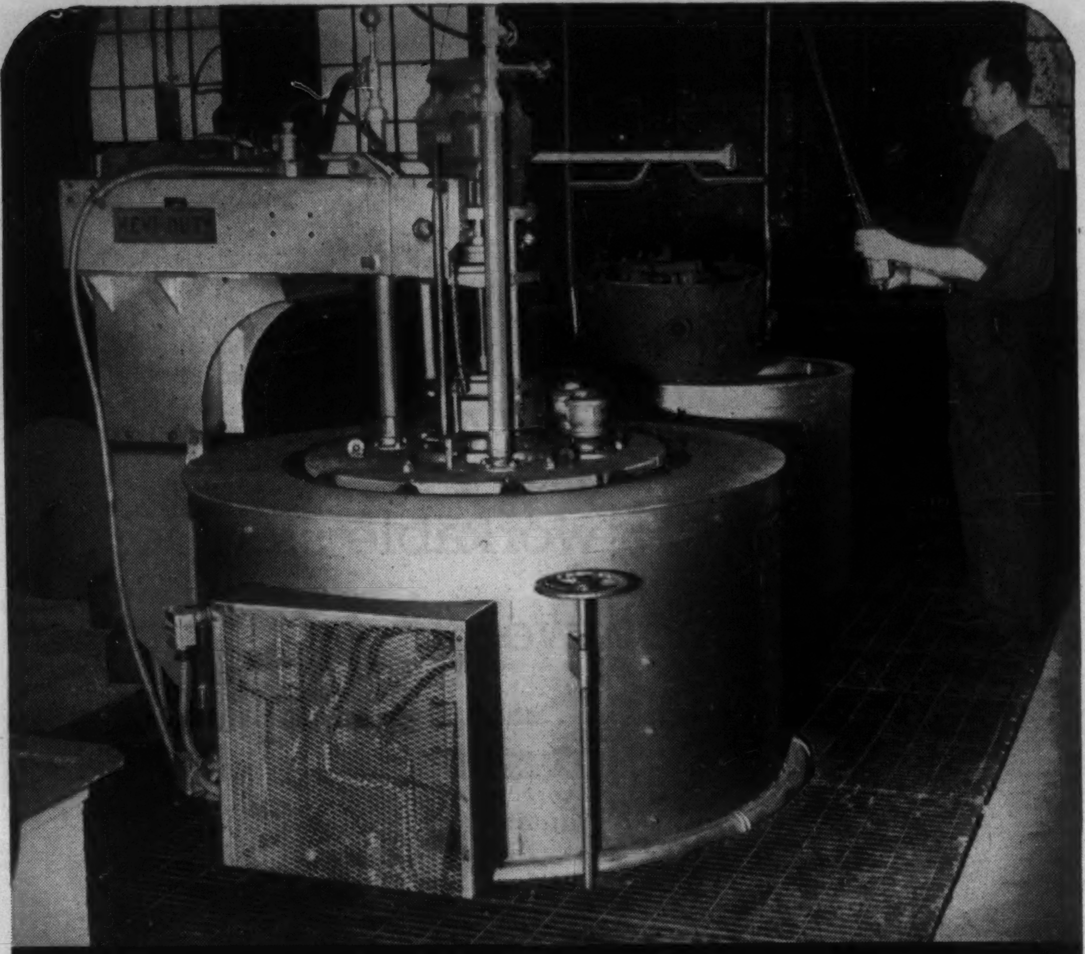


CARBURIZING TIME CUT
4 HOURS with a

HEVI DUTY

FURNACE

Electrol Inc., manufacturers of hydraulic devices, carburizes landing gear orifice tubes in 3 hours instead of 7 hours formerly required by the pack method.

Edgar B. Roesch, Factory Manager, says, "With this Hevi Duty Retort Furnace, we can produce a more uniform case faster because —

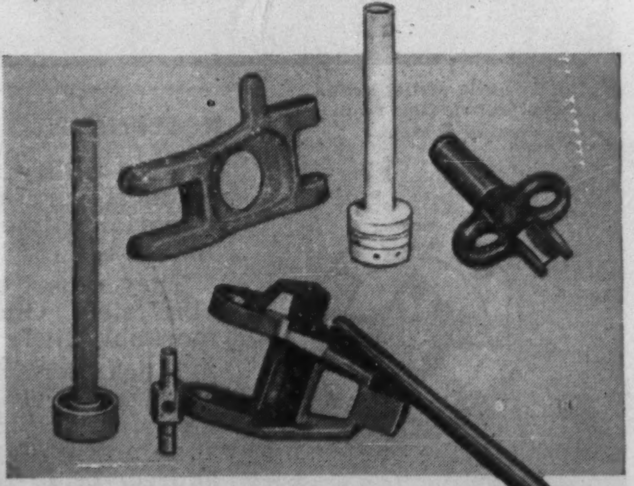
Forced Circulation assures even case depth throughout the densest loads.

Zone Temperature Control helps bring the load up to temperature more quickly and evenly.

Positive Pressure inside the retort has simplified the obtaining of exact carbon concentrations on the surface of the work and to specified depths."

The carburizing atmosphere is supplied from a Hevi Duty Endothermic Generator to which natural gas is added.

This atmosphere protects the work from scaling which results in a further saving of 50% in surface finishing time.



Write for Bulletin HD-646-R and more information about how the Hevi Duty Retort Furnace is used for carburizing, hardening, nitriding, and bright annealing.

HEVI DUTY ELECTRIC COMPANY
MILWAUKEE 1, WISCONSIN
Heat Treating Furnaces... Electric Exclusively
Dry Type Transformers *Constant Current Regulators*

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news of | COMPANIES

million dollar titanium tetrachloride producing plant at Natrium, W. Va.

Esso Standard Oil Co. has paid the federal government $16,000,000 for transfer to private ownership of the Baton Rouge, La., synthetic rubber plant, which it has operated for the government since 1942.

The Glidden Co. has purchased the assets of the Zapon Industrial Finishes Div., **Atlas Powder Co.** The new unit will operate as Glidden's Zapon Industrial Coatings Div.

Marblette Corp. has launched a half-million-dollar expansion program to facilitate research and to increase production to keep up with the demand for plastics materials.

The **March Corp.** has announced its formation to engage in applied technical sales of specialized products and services in the high temperature, corrosion resisting and metallurgical fields.

The Mitchell-Bradford Chemical Co. has recently completed construction of a new plant at 2446 Main St., Stratford, Conn.

The **Niobium Corp.** has been formed to reclaim strategic metals such as cobalt, nickel and columbium (niobium) from stainless steel scrap. The plant is located at 62-16 Woodhaven Blvd., Rego Park, Queens, N. Y.

St. Regis Paper Co. has acquired the entire capital stock of Michigan Molded Plastics, Inc. The Michigan company will be known as Michigan Panelyte Molded Plastics, Inc.

The **Sherwin-Williams Co.** has entered the polyester plastics field.

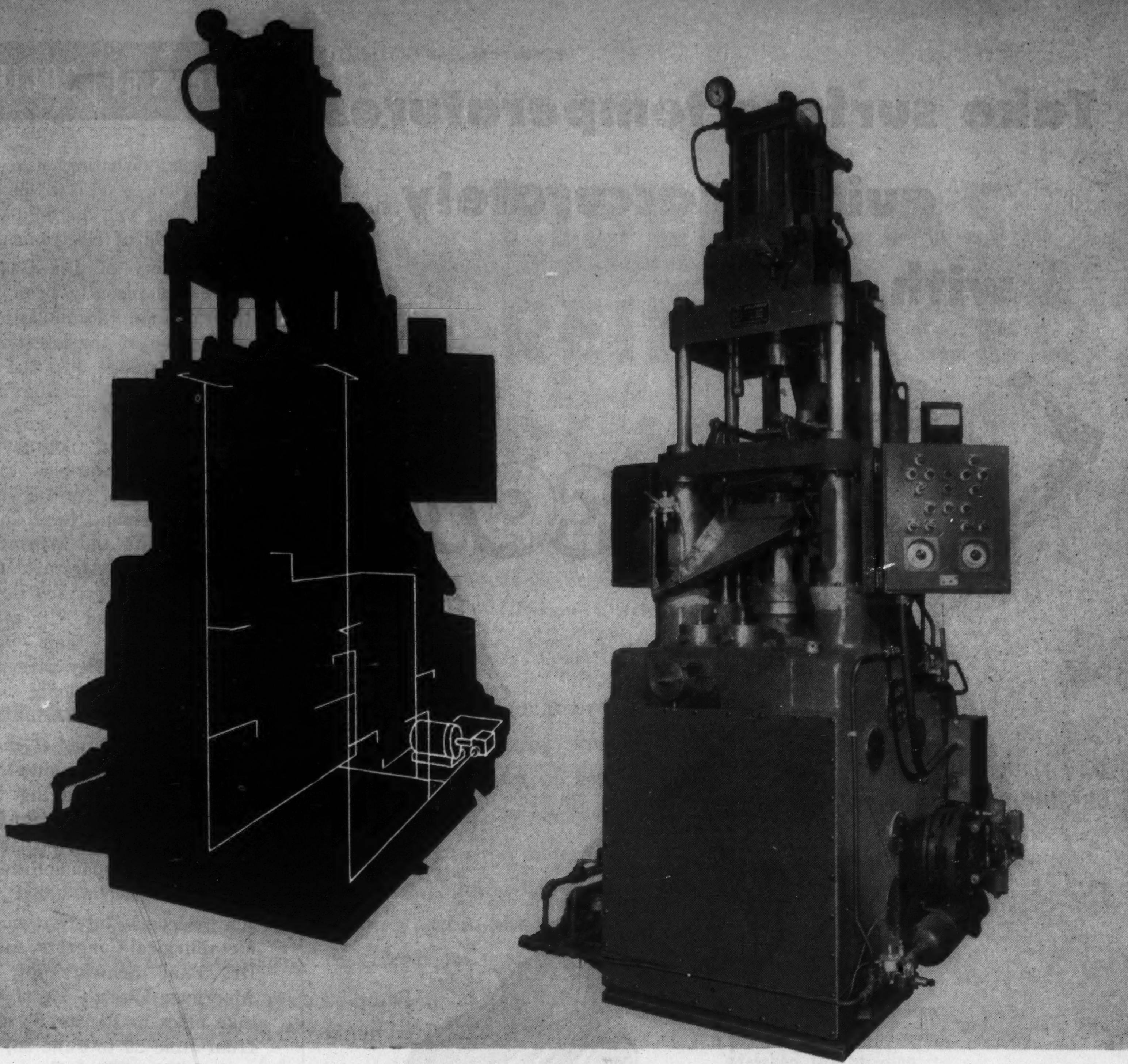
Westinghouse Electric Corp. has announced plans to build a $6,500,000 nuclear materials test reactor.

The **White Motor Co.** has established a Special Products Div. to handle the development and manufacture of a diversified line of non-automotive products.

news of | SOCIETIES

Massachusetts Institute of Technology has planned a two-week Special Summer Program on "Behavior of Materials at Elevated Temperatures" to be given July 11 through July 22, 1955.

The **Institute of Radio Engineers** has named Dr. E. A. Lederer, chief



Model L

AUTOMATIC LUBRICATION protects new Baldwin powdered metal presses

Baldwin Model "L" and "C" powdered metal presses are just what you need for highest-quality and lowest-cost production. That's true because these new 50 and 100 ton presses are the first designed specifically for compacting metal powders.

A big reason why you'll get such low cost production is their automatic lubrication. In both presses a gear type oil pump, independently driven by a fractional horsepower motor, automatically lubricates all moving parts continuously. It forces filtered oil through a drilled crankshaft to the crank and connecting rod bearings. It pressure lubricates all other bearings subject to load.

Baldwin Model "L" and "C" presses are designed so that all moving parts are completely enclosed and sealed. Abrasive powder and dirt can't get into the bearings. These presses automatically fail to operate unless there is oil pressure in the lubricating system. An easily serviced oil filter provides further protection.

No other powdered metal presses have been designed just to meet your end product's needs. That's why Baldwin's new presses are your best buy. Only they can give you such uniform compacts and so little press maintenance because they both have automatic lubrication, hydraulic heads, shuttle type feeders, sealed mechanism, simple fill adjustments and variable cycling.

For more details about "L" and "C" please write to our Dept. 3823, Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pa.

EDDYSTONE DIVISION

BALDWIN-LIMA-HAMILTON

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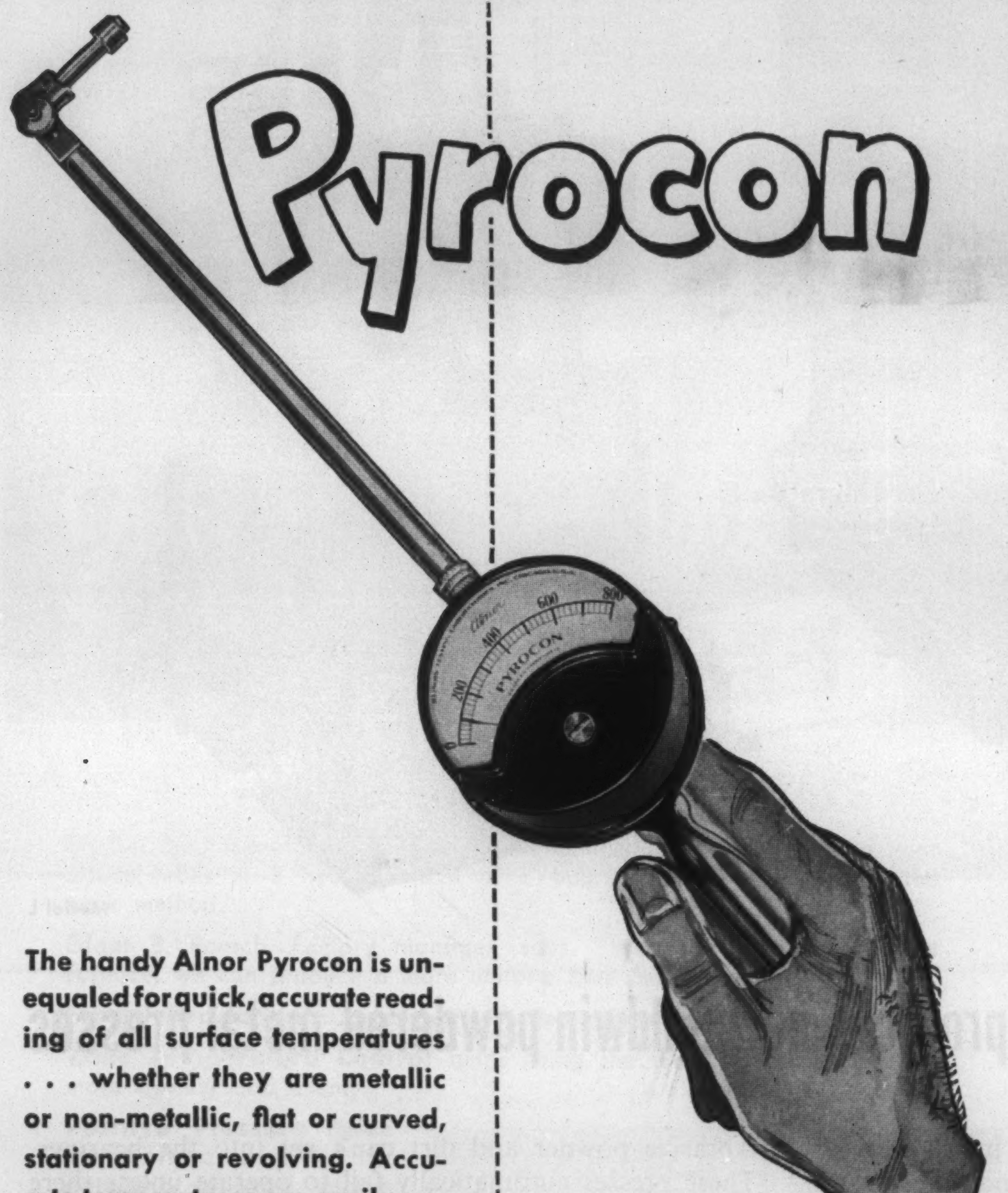
Take surface temperatures quickly, accurately... with the

Pyrocon



The handy Alnor Pyrocon is unequaled for quick, accurate reading of all surface temperatures . . . whether they are metallic or non-metallic, flat or curved, stationary or revolving. Accurate temperatures are easily understood on the Pyrocon's direct reading scale face . . . without interpolation or need of conversion tables. A wide selection of thermocouples and extension arms permits adaptation to many types of service. For complete details and prices, send for Bulletin No. 4257. Illinois Testing Laboratories Inc., Room 522, 420 N. LaSalle Street, Chicago 10, Ill.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

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engineer, Westinghouse Electronic Tube Div., a Fellow in recognition of his long and distinguished service in the field of electronics.

The Society of Die Casting Engineers has recently been formed for the exchange, accumulation and dissemination of the latest information and knowledge in the arts and sciences of die casting and related arts.

The Society of Automotive Engineers has awarded the Wright Brothers Medal for 1954 to John M. Tyler, chairman, Noise Control Committee, Pratt and Whitney Aircraft Div., United Aircraft Corp., and Edward C. Perry, Jr., Research Department, United Aircraft Corp., in recognition of their paper, "Jet Noise", which they presented at the 1954 SAE National Aeronautic Meeting in New York.

The Porcelain Enamel Institute has announced the retirement of Edward Mackasek as managing director of the Institute. John C. Oliver, the Institute's secretary, will assume Mr. Mackasek's responsibilities in addition to his own.

The Second International Powder Metallurgical Congress, sponsored by Dr. Paul Schwarzkopf, president, American Electro Metal Corp., will take place in Reutte, Tyrol, Austria, from June 20 to June 23, 1955. The topic will be "High Temperature and Corrosion-Resistant Materials by Powder Metallurgy".

(Meetings & Expositions on p. 232)

Coming Next Month

How to Select a Steel

A comprehensive guide for engineers and designers. (M & M Manual No. 117)

Rigid, Heat-Resistant Polyethylenes

A New Kind of Clad Metal

An Index for Materials Data

Tear-Resistant Silicone Rubber

Printed Circuit Materials

Heat Treating Aluminum Castings

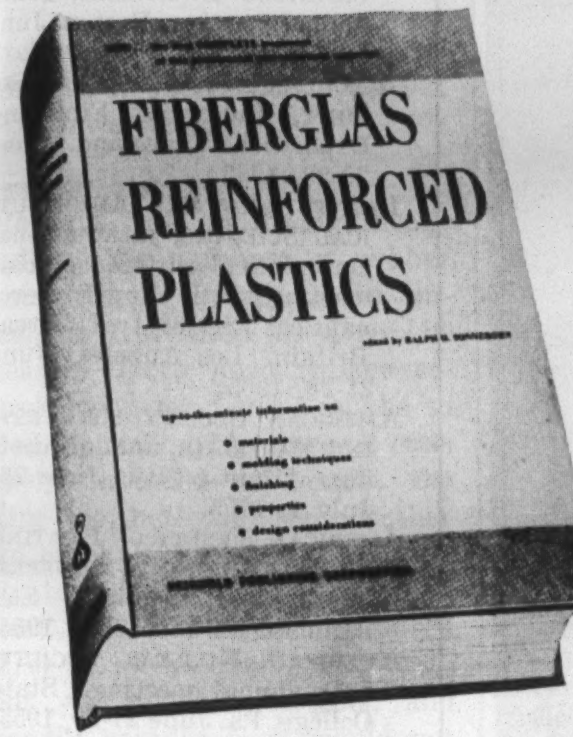
Cellulose Acetate Molding Materials

Short-Run Powder Metal Parts

Molded-In Finish for Reinforced Plastics

Silicon in Submerged Arc Welds

Here's latest information on a
phenomenal new structural material!



FIBERGLAS REINFORCED PLASTICS

Edited by RALPH H. SONNEBORN

Technical Service Dept., Plastics Reinforcement
Division, Owens-Corning Fiberglas Corporation

This valuable new book offers the first *complete* treatment ever published on the subject of reinforced plastics, the amazing post-war structural material that has found its way into scores of new industries and products.

Written for both design engineers and executives in the materials industries, the book covers in full detail the resins and glass reinforcements used in reinforced plastics, molding techniques, inspection and testing, properties, and design considerations.

Of special interest are two chapters contributed by leading authorities in engineering research. The first, written by Professor A. G. H. Dietz, Head of the Department of Structural Materials at M. I. T., discusses the theory and fundamental concepts of reinforced plastics. The second, prepared by A. S. Heyser of Reed Research, Inc. deals with design from the viewpoint of the structural engineer.

Publication of this important new book will provide all those concerned with reinforced plastics—molders, materials suppliers, government agencies, engineers—with a wealth of information never before available in a single volume.

1954, 250 pages, $4.50

Examine this book for 10 days FREE!

REINHOLD PUBLISHING CORPORATION
Dept. M-823, 430 Park Ave., New York 22, N. Y.

Please send me a copy of Sonneborn's FIBERGLAS REINFORCED PLASTICS for 10 days' Free Examination. After 10 days, I will send you $4.50 plus postage or I will return the book and owe nothing.

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SAVE MONEY: Enclose $4.50, and we pay all postage charges. Same return privilege; refund guaranteed.

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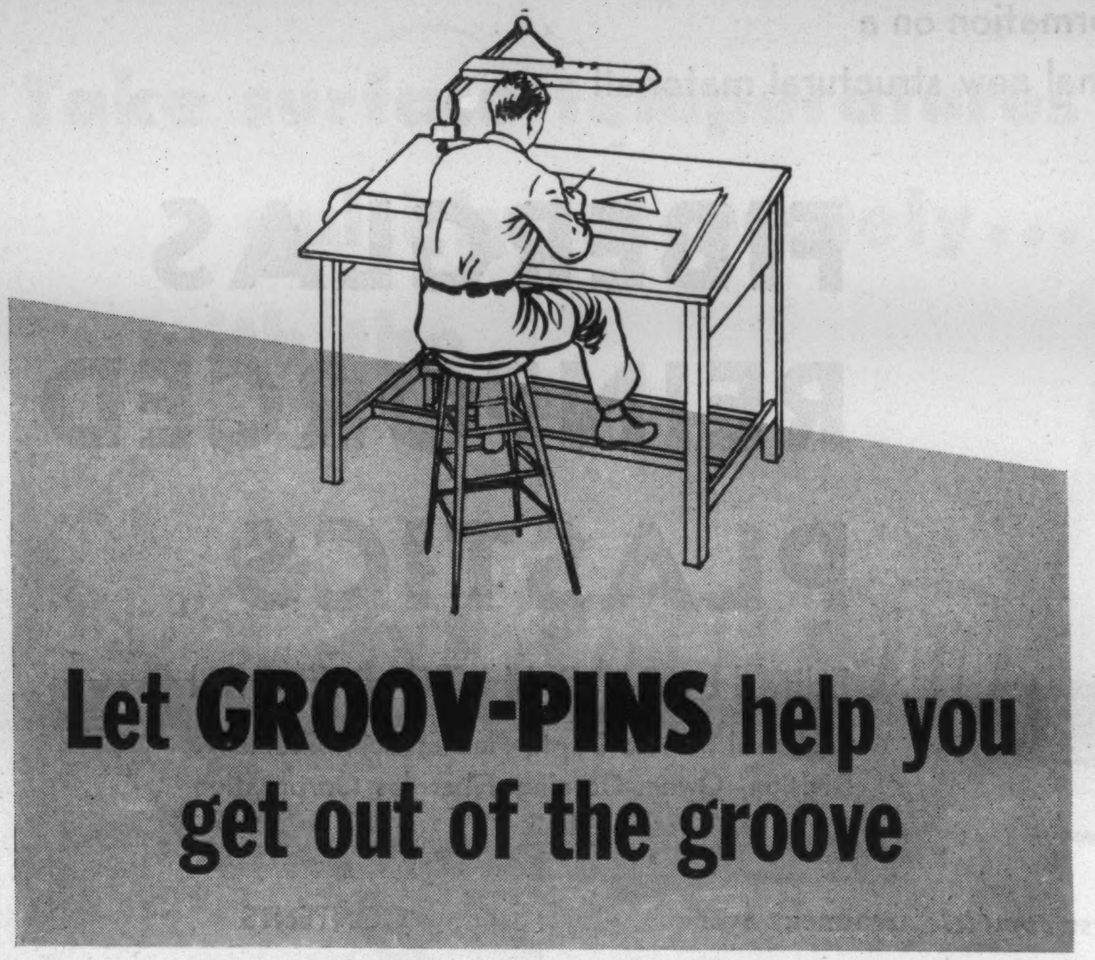

Let GROOV-PINS help you get out of the groove

It is easy to get into a groove in product design and redesign. This is particularly true where fasteners are concerned. With some design engineers it is threaded fasteners or nothing. The possibilities for decreasing the cost and increasing the usefulness of their products through the use of pin fasteners, where applicable, are ignored.

By contrast, many of the best-designed products in the country incorporate Groov-Pins in their construction. A large number of prominent American manufacturers have used Groov-Pins for a quarter century or more with substantial savings in manufacturing and maintenance costs, simplification of design, and customer satisfaction.

The Groov-Pin is a cylindrical metal pin (usually cold-rolled steel) cut from bar or coil stock. Longitudinal grooves are rolled or pressed into the body to deform the stock within controlled limits. When the Groov-Pin is forced into a drilled hole of correct diameter, the constraining action of the hole wall causes the displaced material to flow back and make a locking fit within its elastic range. Resiliency of the pin stock makes it practicable to use the same pin repeatedly.

Groov-Pins are assembled in straight drilled holes. No tapping, reaming, peening or milling are required. They can be driven by hand hammer, air cylinder or hydraulic press.

Send for samples and descriptive folder.

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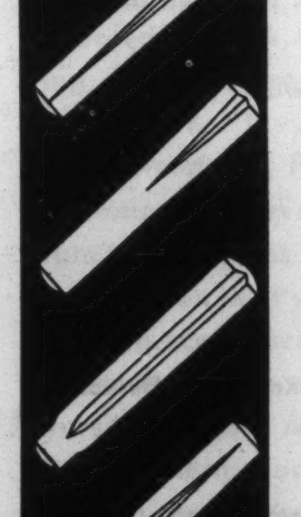
Also manufacturers of TAP-LOK INSERTS.

GROOV-PIN TRADE MARK REG. U.S. PAT. OFF.

GROOV-PIN CORPORATION

1121 Hendricks Causeway Ridgefield, New Jersey

For more information, turn to Reader Service Card, Circle No. 356



Typical Groov-Pin Forms

Meetings & Expositions

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. Boston. June 19-23, 1955.

AMERICAN ELECTROPLATERS' SOCIETY, Industrial Finishing Exposition. Cleveland. June 20-23, 1955.

INSTITUTE OF THE AERONAUTICAL SCIENCES, international aeronautical conference, joint meeting with Royal Aeronautical Society of Great Britain. Los Angeles. June 21-24, 1955.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. Atlantic City. June 26-July 1, 1955.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, semi-annual meeting. San Francisco. June 27-29, 1955.

AMERICAN NUCLEAR SOCIETY, first annual meeting. State College, Pa. June 27-29, 1955.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer general meeting. Swampscott, Mass. June 27-July 1, 1955.

SOCIETY OF AUTOMOTIVE ENGINEERS, West Coast meeting. Portland, Ore. Aug. 15-17, 1955.

METALWORKING MACHINERY & EQUIPMENT EXPOSITION. Chicago. Sept. 6-17, 1955.

METAL POWDER ASSOCIATION, fall meeting. Hot Springs, Va. Sept. 9-11, 1955.

INSTRUMENT SOCIETY OF AMERICA, Annual Instrument Conference & Exhibit. Los Angeles. Sept. 12-16, 1955.

PORCELAIN ENAMEL INSTITUTE, Annual Shop Practice Forum. Columbus, Ohio. Sept. 14-16, 1955.

STANDARDS ENGINEERS SOCIETY, fourth annual meeting. Hartford, Conn. Sept. 29-Oct. 1, 1955.

WORLD PLASTICS FAIR AND TRADE EXPOSITION. Los Angeles. Oct. 5-9, 1955.

ELECTROCHEMICAL SOCIETY, fall meeting. Pittsburgh. Oct. 9-13, 1955.

SOCIETY OF AUTOMOTIVE ENGINEERS, aeronautic meeting, aircraft production forum and aircraft engineering display. Los Angeles. Oct. 11-15, 1955.

NATIONAL METAL EXPOSITION AND CONGRESS. Philadelphia. Oct. 17-21, 1955.

STEEL FOUNDERS' SOCIETY OF AMERICA, fall meeting. White Sulphur Springs, W. Va. Oct. 24-25, 1955.

PORCELAIN ENAMEL INSTITUTE, annual meeting. White Sulphur Springs, W. Va. Oct. 26-28, 1955.

News Digest

continued from page 12

switchover, with some rising slightly and others balancing out on the lower side.

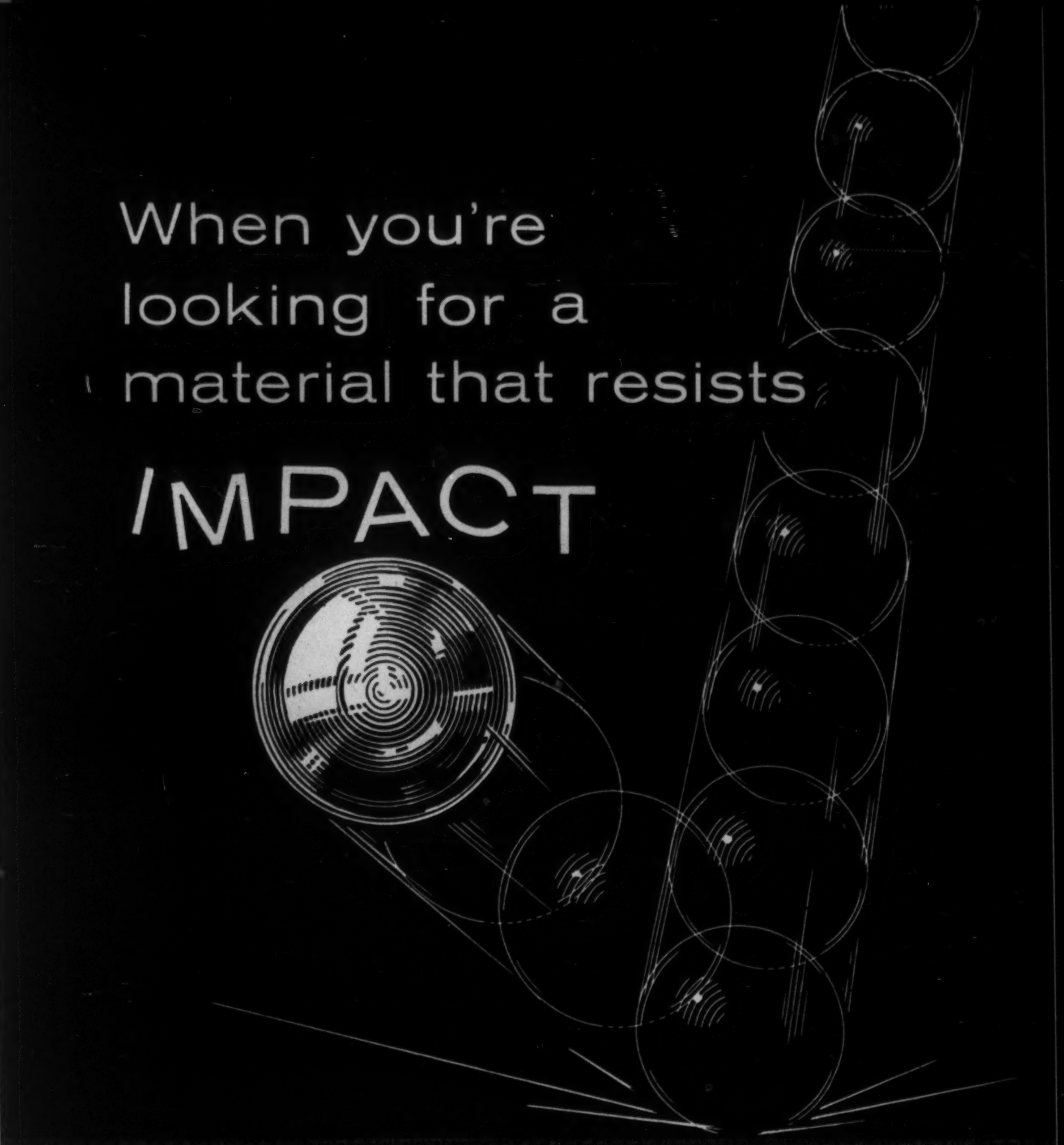
Research changes

Perhaps the most significant result of the purchase of rubber plants will be the change in emphasis in GR-S and butyl rubber research. Until now, rubber research has tended to be on the so called "pure" side, since it was largely intended to benefit the entire synthetic industry rather than emphasize a special product. Private industry was reluctant to invest much in rubber research —first of all because the government was in it so deeply, and secondly because they would not enjoy the profits—all synthetic rubber developments had to be shared. Now, private industry will turn loose its development engineers on the problems of applied research—and incidentally, may turn loose some developments and ideas that have been held in abeyance until the possibility of a better return on their investment was more favorable. So new developments should be expected.

More competition?

Many in the rubber industry foresee the beginning of an era of greater competition and increased stability. The 13 GR-S plants will be competing against each other and against other synthetics and natural rubber in a world market that is not consuming all the rubber that can be made. Also, other elastomers, such as the polyeurethanes, the alfins, and neoprenes will keep the industry alert to quality, price and property differentials. Of all the elastomers likely to be hurt, the natural rubbers stand out. There is widespread sentiment in this country to make the U S independent of foreign sources and the argument that the Far Eastern rubber producing countries are in danger of political and economic upheaval carries considerable weight. P. W. Litchfield, chairman of the board of Goodyear Tire & Rubber, recently forecast that the U S rubber consump-

For more information, Circle No. 351 ➤



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M&M 6-5

How REVERE saves money, metal and time with

SPERRY REFLECTOSCOPES

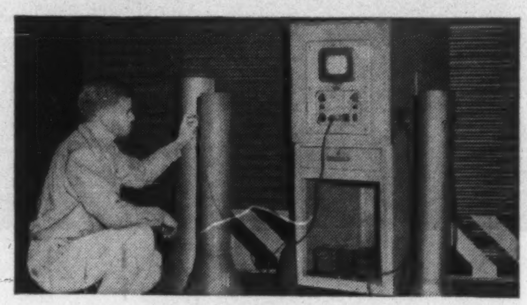
Operator probes 8-in. diameter, 7- to 8-ft. round aluminum ingots from end and along axis for flaws. Test is simple, fast and accurate; keeps step with high-speed production; saves metal, money and time.

Line casting aluminum ingots is a high-speed operation at the Baltimore plant of Revere Copper and Brass. Fast testing for flaws in castings is vital to their quality control.

The old testing method – cutting, machining and etching discs – put a big time lag between casting and defect detection.

The new testing method – probing ingots ultrasonically with a Sperry Reflectoscope – cuts that time lag tremendously. Performed immediately after casting and cooling, test shows defects instantly. Casting procedure can be promptly altered. Ingot defects are pin-pointed and cut out – only sound metal passes.

Revere also uses Reflectoscopes for production maintenance – checking hydraulic extrusion rams, tie rods, bolts, stems and other highly stressed parts for fatigue cracks – insuring against equipment breakdowns. Thus, Revere gets double-barreled savings from Sperry Reflectoscopes.



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News Digest

tion in 1960 would be 72% synthetic and that our natural rubber consumption would decrease despite a general rise in rubber goods production.

Natural rubber is still necessary for production of the best tires for automobiles—since its superior heat properties cannot be duplicated in synthetic elastomers at competitive prices. However, synthetic rubber prices are considerably lower than natural rubber prices now, and while there is little chance of their rising, the cost of natural rubber may be expected to rise in proportion to the increasing labor costs of rubber producing countries.

The synthetic rubber industry is far from mature, being scarcely twelve years old. It has grown in that time to supply nearly 60% of the nation's rubber needs, and has done that under government controls that might be called stifling in other industries. On the free market, with the full competitive applied research and sales push of the nation's rubber producers behind it, the estimate of 70% of the nation's market going to synthetics may be indeed conservative.

Zirconium Prices Slashed

Carborundum Metals Corp. reduced zirconium prices up to 40% last month. Under the announced new price schedules, commercial grade zirconium ingots of 500 lb and over now cost $14.40 per lb, a sizeable reduction from the previous price of $22.00 per lb.

Low hafnium grade zirconium, a key material in nuclear reactor core structures, was also reduced in price. Reactor grade sponge, formerly $22.00 per lb, will be sold as low as $14.00 per lb. Low hafnium ingot, formerly $33.00 per lb. is now priced at $23.00. A few years ago, low hafnium zirconium was a very rare material, and demanded a price of better than $123 per lb. The price fell soon after Carborundum Metals,

. . . . AN AIR REDUCTION PRODUCT

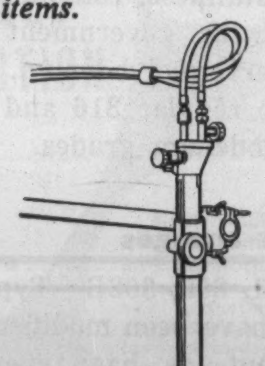
AIRCO items for flame cutting

The Airco 3000 Series Cutting Torches have the same rugged design features as the 9000 Series (shown at left). The principal difference is that the high-pressure oxygen control mechanism is designed so the cutting oxygen can be eased on gradually. This is particularly helpful in hole piercing, rivet washing, or rivet and stay bolt cutting.

The 3000 Series is also suitable for general purpose cutting of steels ranging from thin gauge to 12″ thicknesses.

Airco two-hose and three-hose machine cutting torches are designed for use with standard Airco tips. The two-hose torches are for light and medium machine gas cutting primarily with Airco portable gas cutting machines like the Radiagraphs and Monographs.

The three-hose torches are for use with large Airco shape cutting machines such as the Duograph, Oxygraph, and Travograph. *Write for literature on these items.*



WELDING SHOW

VISIT BOOTH 254

News Digest

the world's only commercial producer of low hafnium zirconium, went on-stream two years ago. The price reductions, both past and present, are attributable to improved production, greater demand, and larger volume. A key factor in ingot prices is the ability of fabricators to increase yields from sponge. Among the principal fabricators of zirconium metal, the Carborundum Metals Co. credited Firth Sterling, Superior Tube Co., Allegheny Ludlum Steel Corp., Chase Copper and Brass, Bridgeport Brass, and Simonds Saw and Steel Co. with significant help in attaining a high yield and low reject rate in producing zirconium parts.

Low hafnium zirconium is among the most transparent of materials to thermal neutrons, and is expected to be in greater demand as the commercial power development of atomic energy progresses.

Niles C. Bartholomew, vice president of Carborundum Metals, said on announcing the new prices that they resulted from "our anticipation of further demands resulting from the use of atomic energy throughout the world. Our current price reduction (of low hafnium zirconium) is part of a continuing program to produce high quality zirconium in adequate volume and costs commensurate with economical reactor operation". Bartholomew opined that no further reductions in prices were possible in the immediate future, although long range projections based on the current rate of research progress and larger quantity production indicate that progressively lower prices will be attained in the long pull.

AISI Revises Stainless Designations

Four new additions to the 300 and 400 series of stainless steel designations and significant re-

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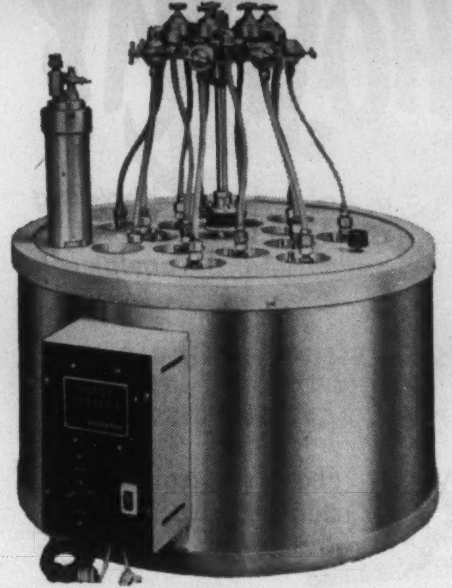
NEW Heating Bath for PRESSURE AGEING

WITH 14 INDIVIDUAL CONTAINERS



for pressure ageing in either air or oxygen . . . .

Scott Tester* Model LGP now provides the highly successful Aluminum Block Heating Bath for pressure ageing of rubber specimens. Has 14 single, removable, seamless stainless steel containers having 1½" x 8" inside dimensions. Each container is equipped with its own controllable source of supply of the ageing medium, which in turn originates from a central manifold. The containers have a quick sealing closure, sample racks, individual safety valve, and purging relief. Instrument is provided with controls to produce temperatures in accordance with industry practice.
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LITERATURE UPON REQUEST

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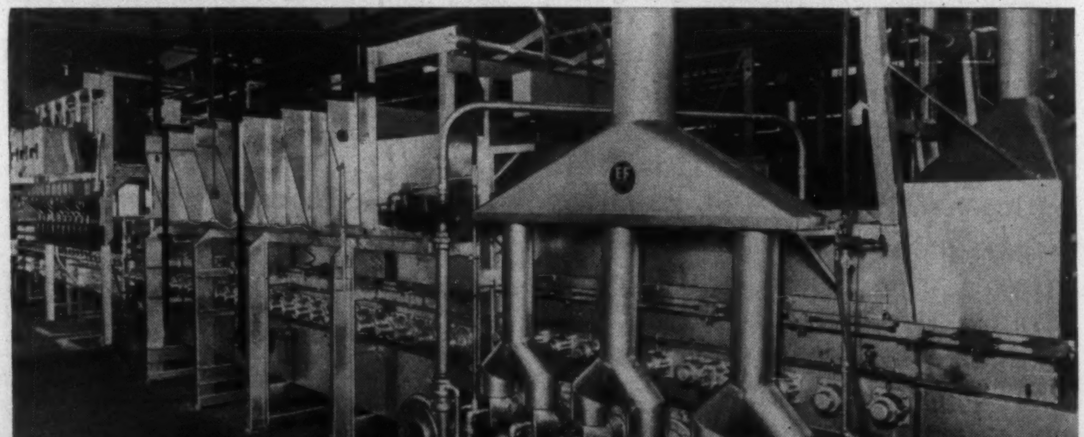
Scott Testers — Standard of the World



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Provide for—

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visions of many other stainless steel analyses have been announced by the American Iron and Steel Institute.

Three of the new stainless steels listed offer high machinability by the addition of selenium. Their designations are 303 Se, 416 Se, and 430 F Se. The fourth new designation is 348, a columbium-stabilized, low-tantalum grade.

The last published changes in stainless alloy designations were released in 1952—largely to comply with NPA orders to restrict the use of critical alloys. The new changes and designations are the result of two developments: improved industry practices, which enable stainless steel producers to work to closer tolerances, particularly on carbon limits; and the lifting of government restrictions, which allows producers to return to pre-Korean analyses.

The three new types of selenium bearing stainless—303 Se, 416 Se, and 430 F Se—provide designers and fabricators of stainless steel with the machinability associated with equivalent sulfur-bearing types. The sulfur-bearing types are most suitable for deep cutting, while the new selenium grades are often preferred for shallow or light cuts.

The new type 348 and a modified 347 replace the TS, or "Tentative Standard", types established under government restriction orders. All tentative standard designations have been eliminated. TS 316 stainless, established to comply with government orders to conserve molybdenum, has reverted to regular 316 and 316L high molybdenum grades.

Type changes

301, 302, 302B—Types 301 and 302 have been modified in carbon content, as has type 302B for high temperature service. Advances in electric melting furnace practice permit industry to meet the more rigid specifications.

304, 304L — Maximum nickel

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this is important enough to read twice!

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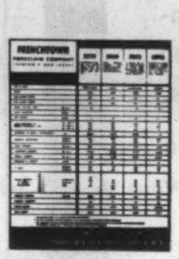

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News Digest

content in these welding grade stainless steels has been raised 1% to provide increased workability for production of seamless tubing.

316 is again available and TS 316 has been eliminated. Carbon content has been reduced. Type 316L differs from 316 by virtue of a lower (0.03) carbon content to minimize the possibility of carbide precipitation.

317—Two modifications have been made to increase the nickel content and reduce the carbon content for optimum hot workability in manufacture of large tubes and plates.

321—Titanium stabilized, has increased in nickel maxima.

347, 348—These are basically columbium stabilized steels. Type 347 has been modified as a conservation measure to permit the use of ores containing both columbium and tantalum. Engineering properties are unchanged. Type 348 was created to fill a limited but significant use for columbium-stabilized, low-tantalum steels. Nickel content of both types has been increased 1% from the previous specification for 347.

405—The chromium content of this 12% chromium material has been increased 1% to better the ability of the metal to meet low quench hardness usually specified for this type of alloy.

446—Carbon content has been reduced from 0.35 max to 0.20 max. Type 446 is a high chromium type with high oxidation resistance.

303Se, 416Se, 430F Se—As discussed above, these new selenium bearing grades have increased machinability. In general, they also have higher phosphorus content than other types of stainless.

ASTM Meets June 27-July 1

Five out of seven symposiums at the 58th annual meeting of the American Society for Testing Materials will cover areas of im-

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1/2"	1-1/4"

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5/16" "	5/8" "
3/8" "	3/4" "
1/2" "	7/8" "
5/8" "	1" "
3/4" "	1-1/4" "
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1" "	1-3/4" "
1-1/4" "	2" "

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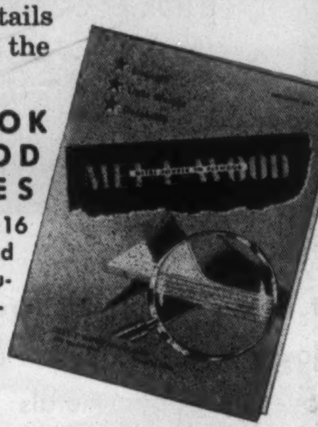

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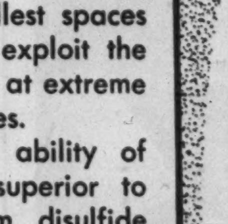

"Information on MOLYKOTE appears in Sweet's Product Design File, 1955, Section C."

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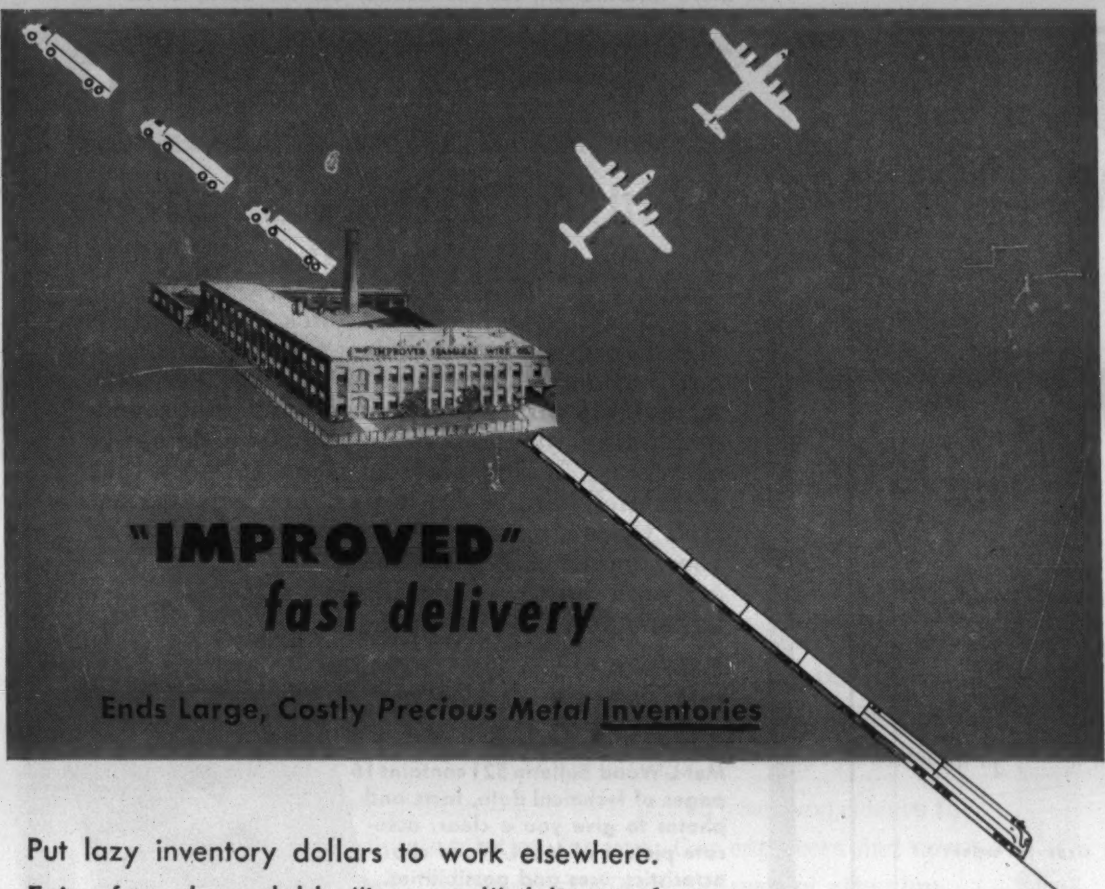
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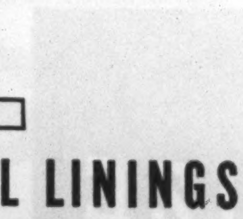

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News Digest

portance to materials engineers. The symposiums, some of them continuing through three days, will be presented on impact testing, high purity water corrosion, atmospheric corrosion of nonferrous metals, speed of testing, and metallic materials for service above 1600 F. Individual papers will be presented in many sessions covering nonferrous metals, steel, concrete, fatigue and effect of temperature.

In addition, about 50 of the Society's main technical committees and their sub-groups have scheduled about 600 meetings in the five-day period.

The annual meeting will be held at Chalfonte-Haddon Hall, Atlantic City, New Jersey, June 27 through July 1.

Marburg Lecture

The annual Marburg Lecture will be presented on Wednesday, June 29 by Dr. Walter J. Hamburger, Director, Fabric Research Laboratories, Inc. Dr. Hamburger will speak on "A Technology for the Analysis Design and Use of Textile Structures as Engineering Materials".

Gillett Lecture

Dr. Fritz V. Lenel, RPI, will deliver the Gillett Lecture, on Tuesday, June 28. His subject will be "Powder Metallurgy—Now".

Program

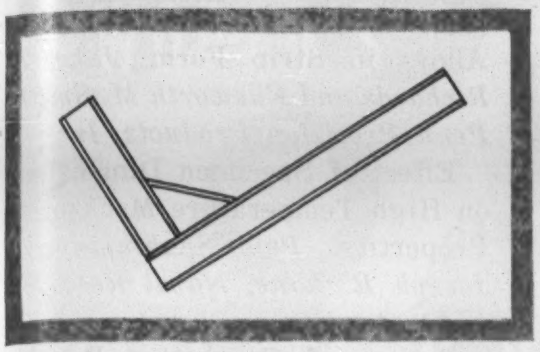
A selected list of papers on engineering materials follows:

■ Tuesday, June 28:

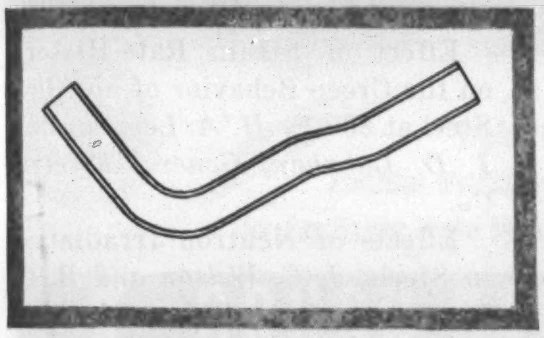
Mechanical Properties of a Magnesium Alloy Under Biaxial Tension at Low Temperatures. *Edward Paxson, Edison Laboratory; Joseph Marin and L. W. Hu, the Pennsylvania State University.*

Strength of Bent Copper Tube. *G. S. Sangdahl, Jr. and W. M. Baldwin, Jr., Case Institute of Technology.*

Factors Affecting the Forming Properties of Several Copper



Change from built-up sections.....



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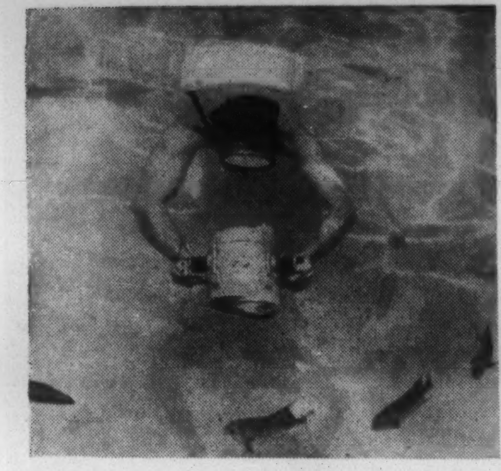

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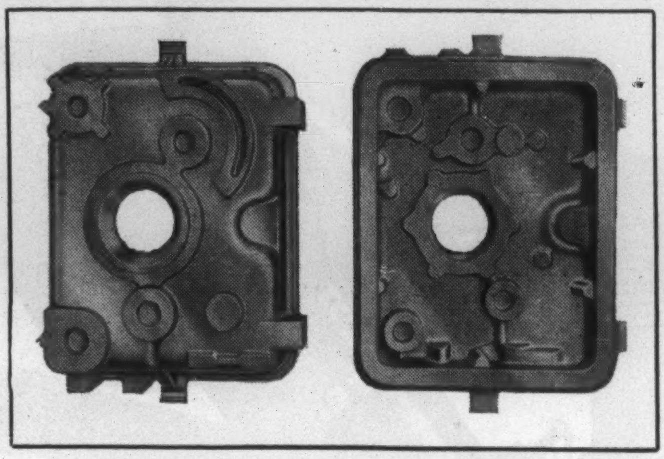

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Alloys in Strip Form. *John T. Richards and Ellsworth M. Smith, Penn Precision Products, Inc.*

Effect of Specimen Dimensions on High Temperature Mechanical Properties. *Paul Shahinian and Joseph R. Lane, Naval Research Laboratory.*

Report of Committee B-1 on Wires for Electrical Conductors. *D. Halloran, Chairman.*

Report of Committee B-5 on Copper and Copper Alloys, Cast and Wrought. *G. H. Harnden, Chairman.*

Effect of Strain Rate-History on the Creep Behavior of an Alloy Steel at 800 F. *H. A. Lequear and J. D. Lubahan, General Electric Co.*

Effects of Neutron Irradiation in Steels, *J. C. Wilson and R. G. Berggren, Oak Ridge National Laboratory.*

Effect of Time and Temperature on Impact and Tensile Properties of Hot-Rolled Low Carbon Steels During Strain Aging. *F. Garofalo, G. V. Smith, and D. C. Marsden, United States Steel Corp.*

An Investigation of the 21% Chromium-10% Nickel Heat-Resistant Alloy. *R. J. Mangone, D. D. Burgan, and A. M. Hall, Battelle Memorial Institute.*

■ Wednesday, June 29:

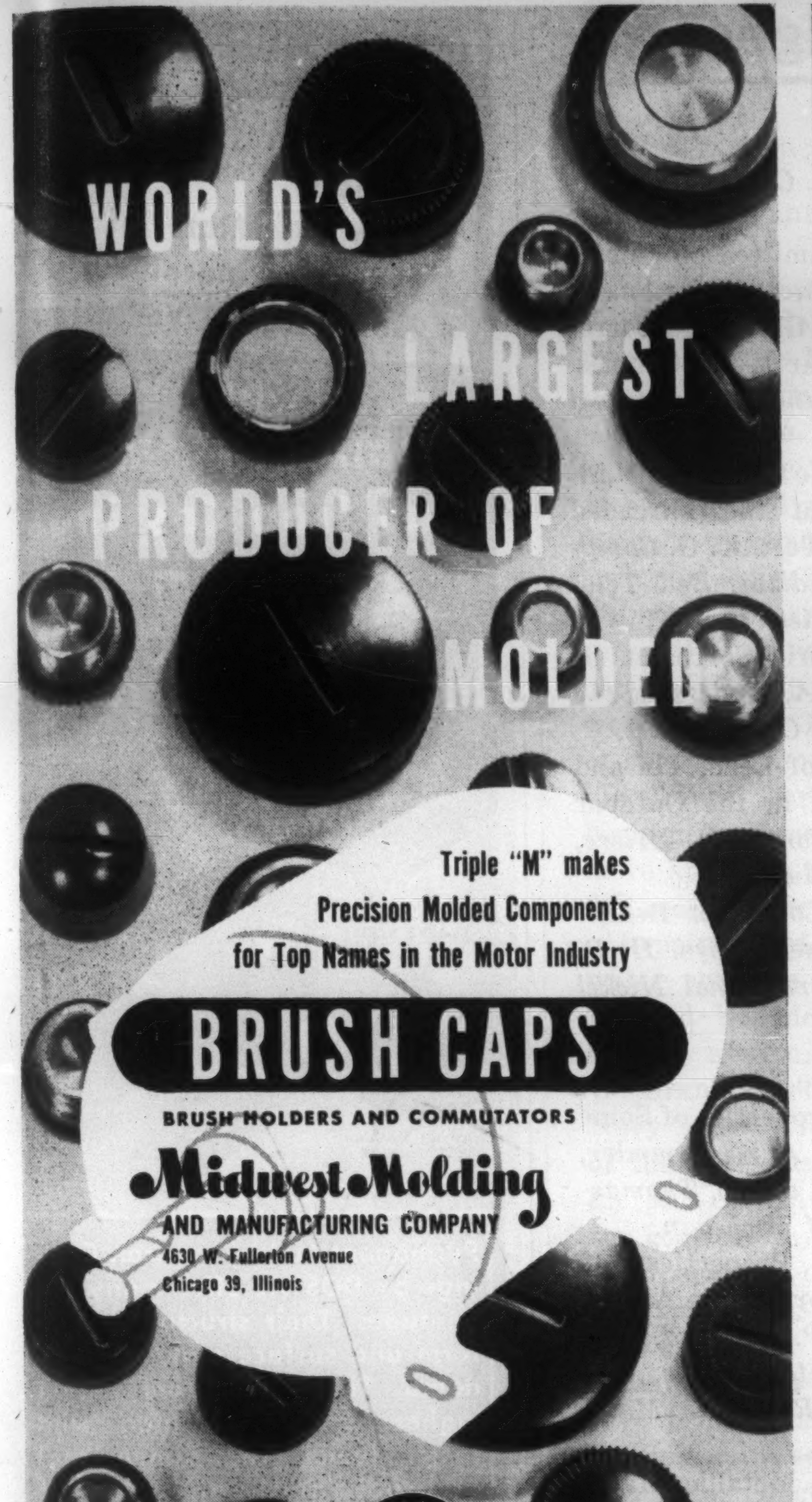
The Resistance of Aluminum-Base Alloys to 20 Year Atmospheric Exposure. *C. J. Walton and William King, Aluminum Co. of America.*

Effect of Marine and Urban Atmospheres on Aluminum Alloys. *Fred M. Reinhart and G. A. Ellinger, National Bureau of Standards.*

Effect of Natural Atmospheres on Copper Alloys—20 Year Test. *A. W. Tracy, the American Brass Co.*

Atmospheric Corrosion of Copper—Results of 20 Year Test. *D. H. Thompson, A. W. Tracy, and John R. Freeman, Jr., the American Brass Co.*

Report of Committee B-3 on Corrosion of Non-Ferrous Metals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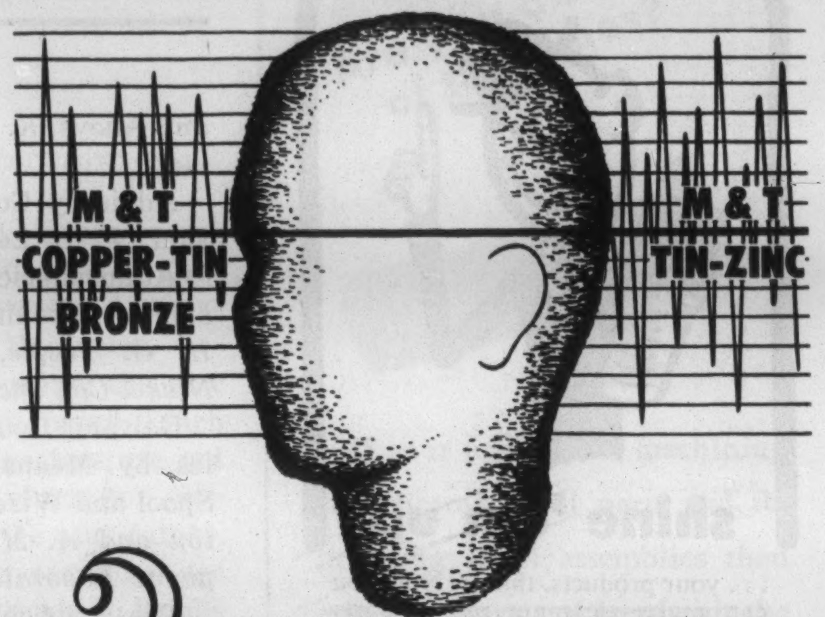
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News Digest

and Alloys. *K. G. Compton, Chairman.*

Advisory Committee on Corrosion. *F. L. LaQue, Chairman.*

Atmospheric Galvanic Corrosion of Dissimilar Metal Couples. *H. O. Teeple, the International Nickel Co., Inc.*

Galvanic Couple Corrosion Studies by Means of the Threaded Spool and Wire Test. *K. G. Compton and A. Mendizza, Bell Telephone Laboratories, Inc.*

The Atmospheric Corrosion of Rolled Zinc. *E. A. Anderson, the New Jersey Zinc Co. (of Pa.).*

The Behavior of Lead, Tin and Antimonial Lead in the Outdoor Atmosphere. *George O. Hiers, Consulting Metallurgist.*

Atmospheric Corrosion Behavior of some Nickel Alloys. *H. R. Copson, the International Nickel Co.*

■ Thursday, June 30:

The Fatigue Properties of Some Titanium Alloys. *A. W. Demmler, Jr., M. J. Sinnott, and L. Thomassen, University of Michigan.*

The Fatigue Properties of Wrought Phosphor Bronze Alloys. *G. R. Gohn, J. P. Guerard, Bell Telephone Laboratories, Inc., and H. S. Freynik, Riverside Metal Co.*

Symposium on Metallic Materials for Service at Temperatures above 1600 F.

Vinyl Paints in Marine Use

Vinyl paints are becoming increasingly well established in marine applications. Not only do they last longer than older protective paints when used alone, but they also seem to perform better when teamed with cathodic protection.

Use of a good vinyl paint system, according to Roy Devluy, of Glidden Co., reduces the number of anodes and the current required for effective cathodic protection of ship hulls. Vinyls seem to be less sensitive than other paints to the tendency of the cathodic current to nullify the inhibiting ac-

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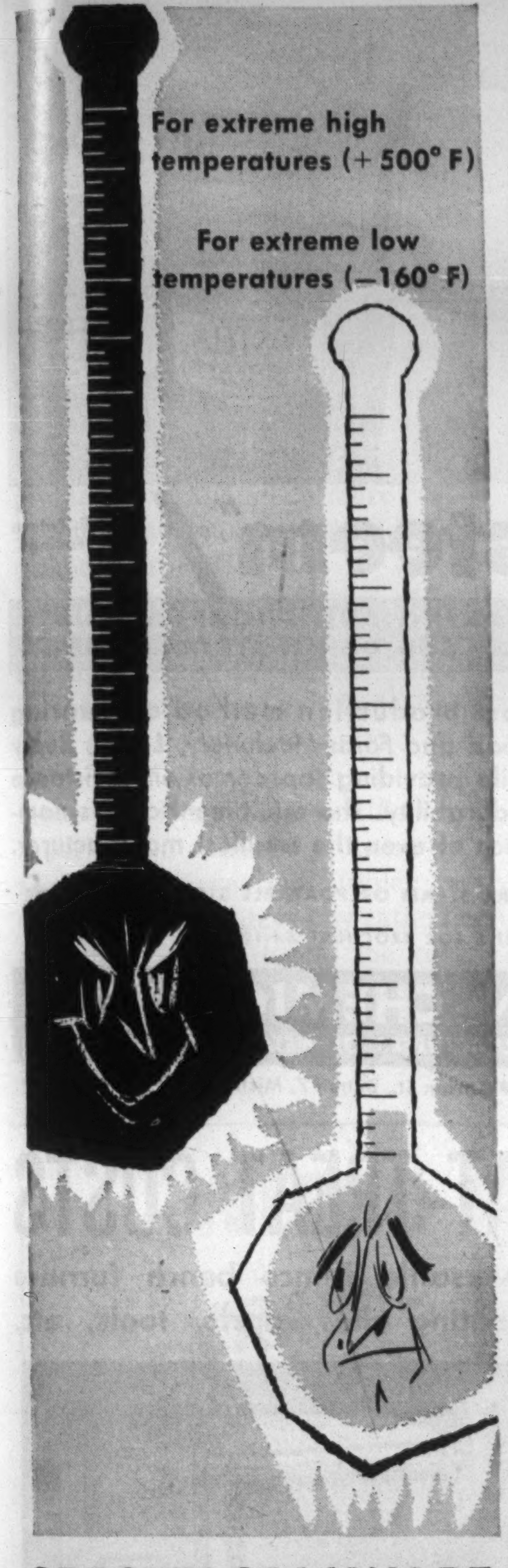
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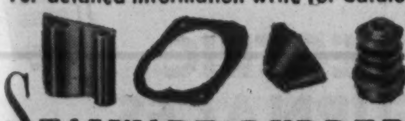

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News Digest

tion of the anti-corrosive paint pigments.

Mr. Devoluy spoke at the recent Northeast Region Corrosion Conference of the National Association of Corrosion Engineers.

According to Devoluy, the new types of protective paints, such as epoxies and polyesters are not likely to supplant vinyls for general marine use in the near future. Shipyard and crew personnel are presently just not ready to handle catalyzed coatings with short working lives. However, coatings of sprayed aluminum or zinc combined with various paints have been quite successful and deserve more attention than they have so far received, he said.

Repainting of submarine abovewater surfaces has been greatly reduced by adoption of a vinyl coating system, according to W. W. Cranmer, of the Philadelphia Navy Yard. The system consists of the widely used "wash primer", an anti-corrosive primer and a top coat of vinyl-alkyd paint.

Superiority of vinyls on ship bottoms is less marked, he said, but a system consisting of the wash primer, 5 mils of anti-corrosive primer and 5 mils of antifouling paint seems to be at least equally as effective as the conventional 30-mil "hot plastic" coating.

Although naval vessels are ordinarily dry-docked every two years, some vinyl-coated hulls have been in service for four years without need of repainting, Cranmer said.

The complex economics of marine corrosion protection were emphasized by another speaker, I. D. Gessow, of the Navy's Bureau of Ships. He concluded that although cathodic protection definitely eliminates corrosion on the forward end of the ship, elimination of pitting at the stern remains to be verified.

Gessow revealed that the potentials found necessary in practice for effective cathodic protection by the impressed-current method were somewhat higher than those generally accepted. Whereas 0.80-

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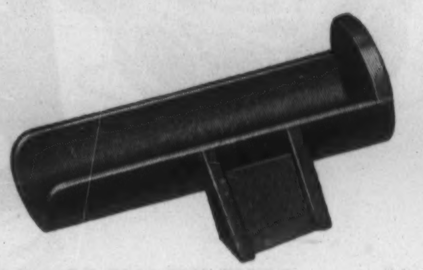

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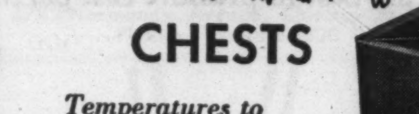

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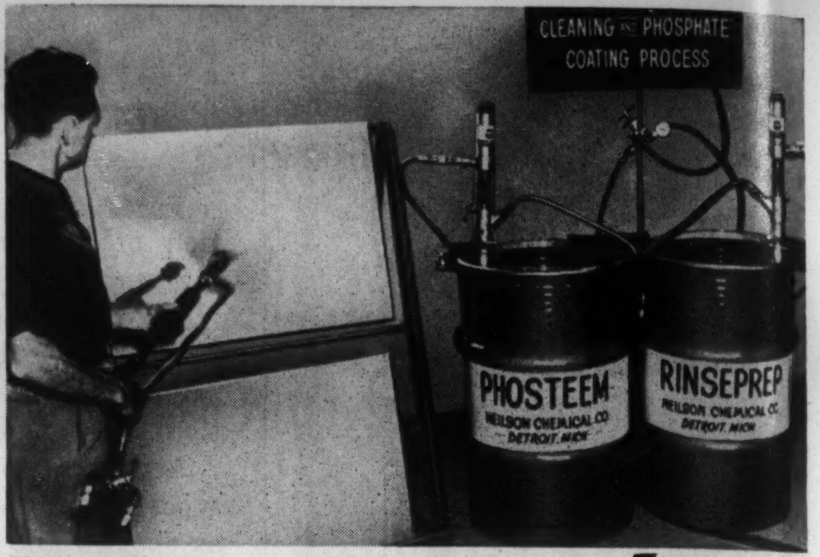
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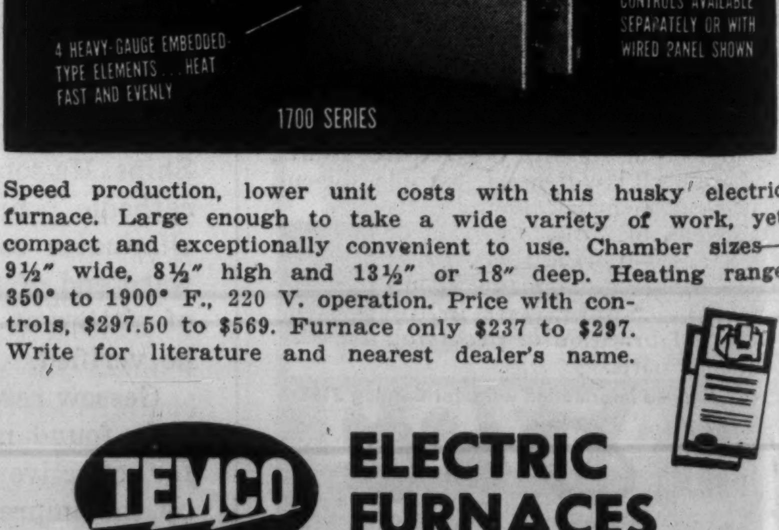
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According to Gessow, sacrificial magnesium anodes last only about 15 months. If they could be made to last two years, they would be preferable to the much more costly impressed-current method of cathodic protection.

Discussions on protection of inboard tanks gave evidence that the approaches to marine corrosion protection are far from unified. Cranmer believes that the use of Saran in lining fuel tanks has been fully justified by experience. Gessow, however, seems to believe that similar results could be achieved by cathodic protection at ⅓ to ¼ the cost. Cathodic protection tests are now underway on ballast tanks, he said.

Electroplaters' Society Meeting, Exposition

American Electroplaters' Society will hold its Industrial Finishing Exposition and 42nd Annual Convention at the Public Auditorium in Cleveland, June 20th through 23rd. This will be the fourth finishing exposition sponsored by AES. It was last held in Chicago, in 1952. The 1955 show will occupy approximately 30,000 sq ft of exhibit area, featuring finishing equipment, services and supplies.

AES is presenting all technical sessions without charge, for the first time, to anyone attending the exposition. Those in attendance should be able to hear a representative group of discussions on subjects they choose because of morning and afternoon scheduling arrangements. No technical papers have been scheduled for Wednesday afternoon, June 22nd.

Papers planned cover subjects in the broad fields of design, con-

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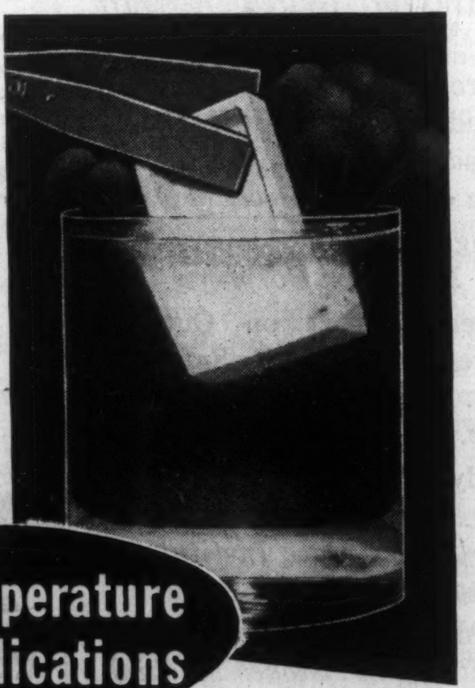

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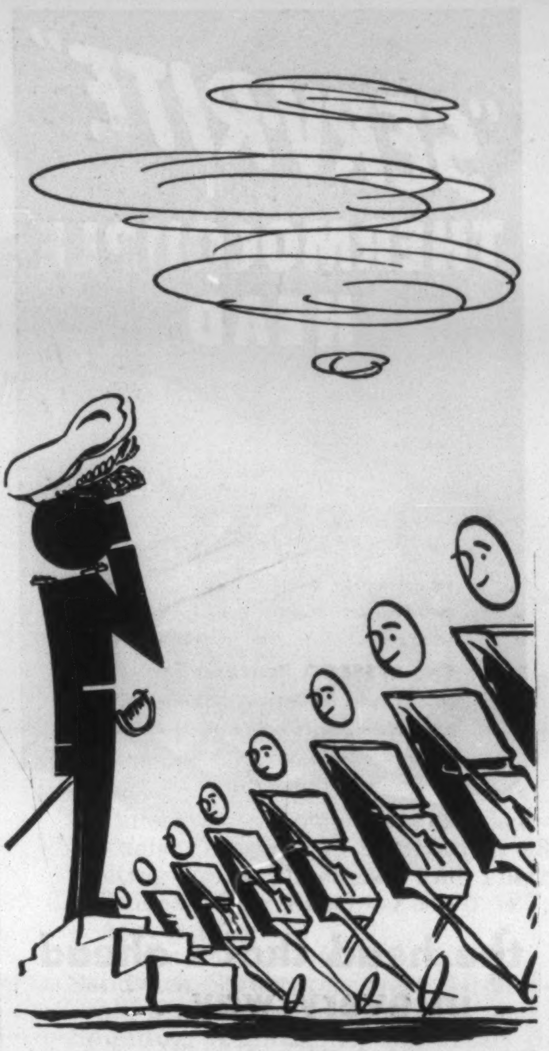

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struction, engineering, maintenance and operations.

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Papers include:

Metal Cleaning Evaluations Using Tagged Soils. *J. Hensley, Wyandotte Chemicals Corp.*

Qualities, Processing and Future of Porcelain Enamel and Ceramic Coatings.

Lead-Tin-Antimony Alloy Plating. *R. T. Putnam and E. J. Roser, Pratt & Whitney Aircraft, div. of United Aircraft Corp.*

Diffused Nickel-Cadmium as a Corrosion-Preventive Plate for Jet Engine Parts. *R. W. Moeller and W. A. Snell, Pratt & Whitney Aircraft, div. of United Aircraft Corp.*

Electroless Nickel Plating of Non-Conductors. *Philip H. Eisenberg and Harold C. Schneider, Sylvania Electric Products Inc.*

Plating Beryllium Copper. *S. J. Morana, Beryllium Corp.*

Progress Report on Outdoor Exposure Tests. *W. H. Safranek and C. L. Faust, Battelle Memorial Institute.*

A Study of Hydrogen Embrittlement in Regards to Electroplating. *Carl Biser, Case Institute of Technology.*

Vacuum Metallizing of Metal. *F. J. Seiter, F. J. Stokes Machine Co.*

Fatigue Limit in Chrome Plated Steel. *By a representative of United Chromium Corp.* A continuation of past studies.

Abrasive Blasting as a Metal Finishing Tool. *C. Forestek, Forestek Plating Co., and G. Haufman, Cleveland Cap Screw Co.* The paper discussed preparation of metal surfaces for plating, and increasing the effective life of dies and tools.

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Materials & Methods
Index of Feature Material

Volume 41, January-June 1955, Inclusive

Material covered in this index includes feature articles, MATERIALS & METHODS Manuals, and Engineering File Facts

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ALUMINUM AND ITS ALLOYS
- Aluminum-Ceramic Bond, New, Produces Hermetic Seal—Apr, p 110
- Aluminum, Heavy Oxide Coating for—Feb, p 132
- Die Castings Cut Weight of Power Mower—June, p 100
- Wrought Aluminum Alloys in Order of Increasing Hardness (File Fact)—May, p 145
- Wrought Aluminum Alloys in Order of Increasing Ultimate Strength (File Fact)—May, p 147

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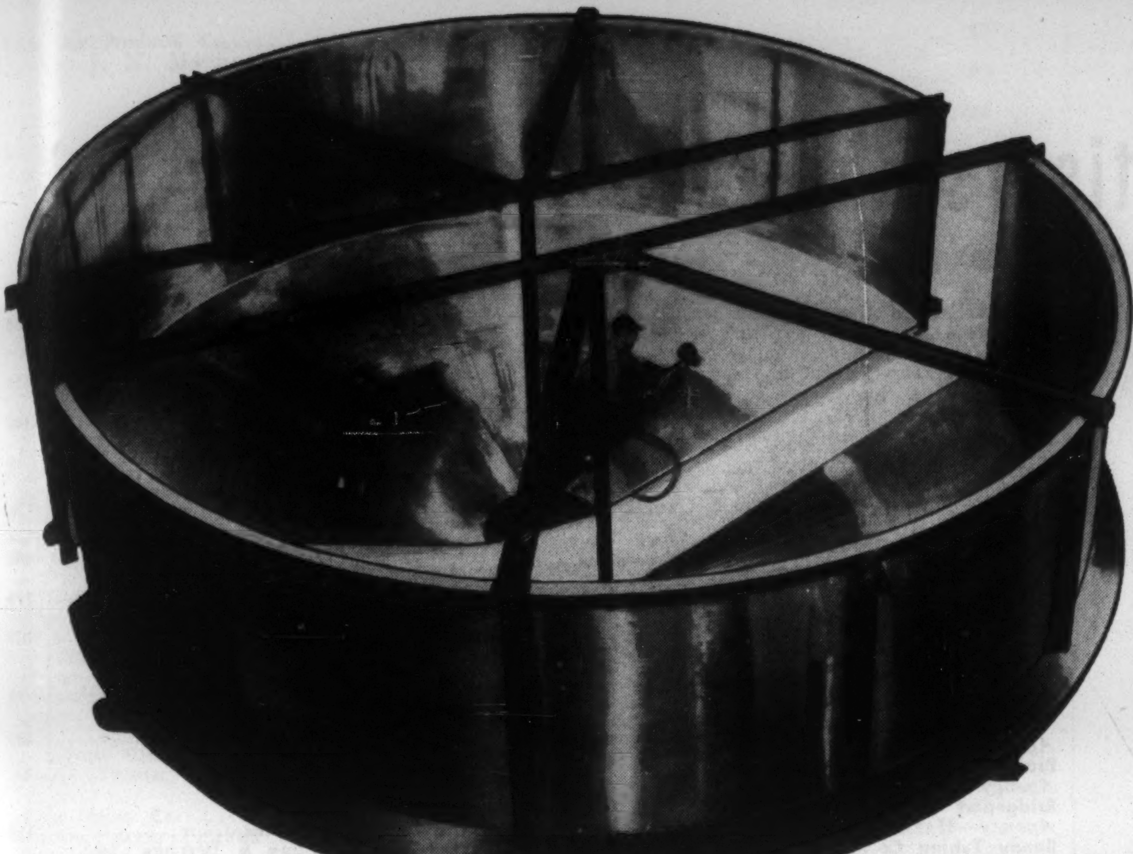

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the last word

Land Ahoy

This cruiser and others who attended the SPI convention aboard the Queen of Bermuda are now recovering their land legs. After being at sea (literally) for the better part of nine days, it became almost second nature to roll slightly when walking. Upon landing back in New York, we had to relearn to walk properly. If the SPI keeps on, it will soon have a group of worldly-wise travelers. Thus far in two cruises they have visited Bermuda, Cuba and Nassau.

Patience Rewarded

About two years ago, some of the boys under his jurisdiction gave U.S. Rubber's Dr. Cadwell a spade to be used when and if ground was broken for his long cherished new laboratories. What started as a gag became a symbol. On May 19 the symbol saw service as Dr. Cadwell used the spade and a million dollars worth of smiles to turn the first earth on the site of the company's new general labs at Preakness, N. J. Incidentally, all golfers should give their votes of thanks to the good doctor, for he is responsible for the tough Cadwell covers which are used on all first-line golf balls. As for me, I could use them even tougher than they are.

Editorial Prize

Over the years, MATERIALS & METHODS has been proud of its record of winning awards in editorial competitions. Recently we won another in the annual event sponsored by Industrial Marketing. A Certificate of Editorial Excellence has been awarded for our 1954 article, "135 Case Histories Show How to Reduce Costs through Better Materials Selection." Now we're busy trying to provide articles which will win more prizes next year. Now to wax a bit philosophical: no matter how many prizes we win, we can't be considered successful unless we satisfy and help our readers. Thus the best prize we seek is the renewed subscriptions of our 28,000 (plus) readers.

Our Roving Correspondent

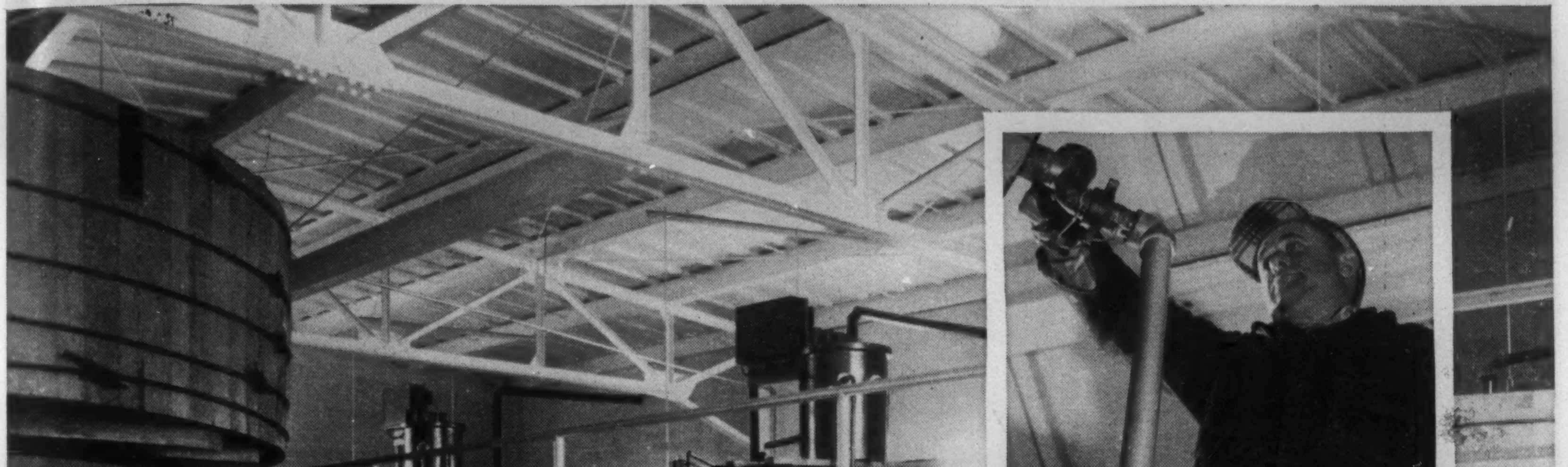
For those of you who might have missed the shining face of our roving Midwest editor, Ken Rose, we have news. At present he is roving far afield. Chicago, Detroit, Cleveland, etc., are now far from his mind as he records with his movie camera the wonders of Hawaii, Japan, Hong Kong, India and all points between San Francisco and New York. His journeys will take about four months, so he won't be appearing at his usual haunts until sometime in September. Only one word describes our feeling—envy.

T. C. Du Mond

Editor

Another new development using

B. F. Goodrich Chemical raw materials



B. F. Goodrich Chemical Company does not manufacture this pipe. We supply only the Geon resin.

Rigid vinyl pipe pays off in vinegar plant

MANUFACTURING and processing 100-grain vinegar—strong enough to eat holes in steel—means high plant piping and maintenance costs in many food plants. But a manufacturer in Ohio recently showed how to take the bite out of the problem, by piping his vinegar plant with high impact plastic pipe made from Geon resin.

The plant's new rigid vinyl pipe is lighter in weight, less costly, easier to install than conventional pipe . . . shows extreme resistance to vinegar and acetic acid corrosion, inside and out, even up to 150°F. It is easier to clean and maintain, does not scale, will not deteriorate with aging.

The remarkable physical properties and chemical inertness of Geon have led to this kind of problem-solving in many industries. Geon polyvinyl materials are adaptable, versatile, easy to compound . . . for molding, coating, extruding, spraying, and calendering.

To help you improve an old product or build superiority into a new one, complete information is available from Dept. BP-3, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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A DIVISION OF THE B. F. GOODRICH COMPANY

GEON RESINS • GOOD-RITE PLASTICIZERS . . . the ideal team to make products easier, better and more saleable.

GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors

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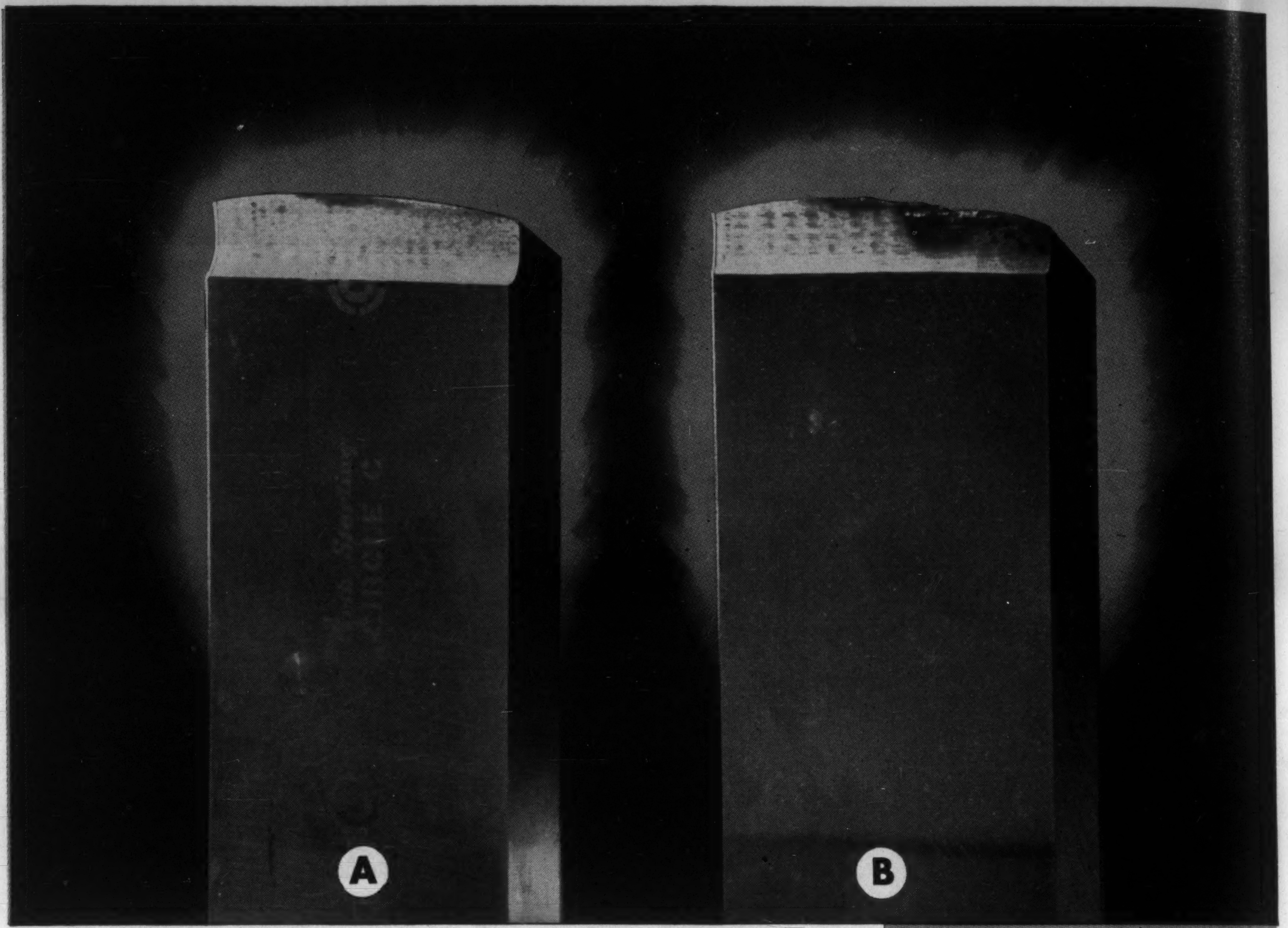


which tool cut leaded steel?

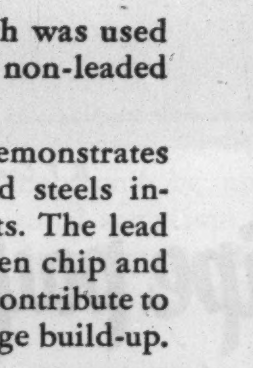
● Right! The answer could only be Tool A which was used on leaded Aristoloy—4140. Tool B was used on non-leaded Aristoloy 4140 under the same conditions.

A comparison of the cutting edges of both tools demonstrates how the freer machining characteristics of leaded steels increase tool life and thereby reduce machining costs. The lead addition acts as a lubricant reducing friction between chip and tool. Tools therefore operate at lower temperature, contribute to better chip formation and eliminate damaging tool edge build-up.

Why not find out what advantages leaded steel can offer you? Call your nearest Copperweld office today for complete information or write us direct.

SEND FOR FREE CATALOG

If you would like specific information about application of lead steel to your product get in touch with your nearest Copperweld office or write us today.



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COPPERWELD STEEL COMPANY

STEEL DIVISION • WARREN, OHIO

For export—Copperweld Steel International Company, 117 Liberty St., New York

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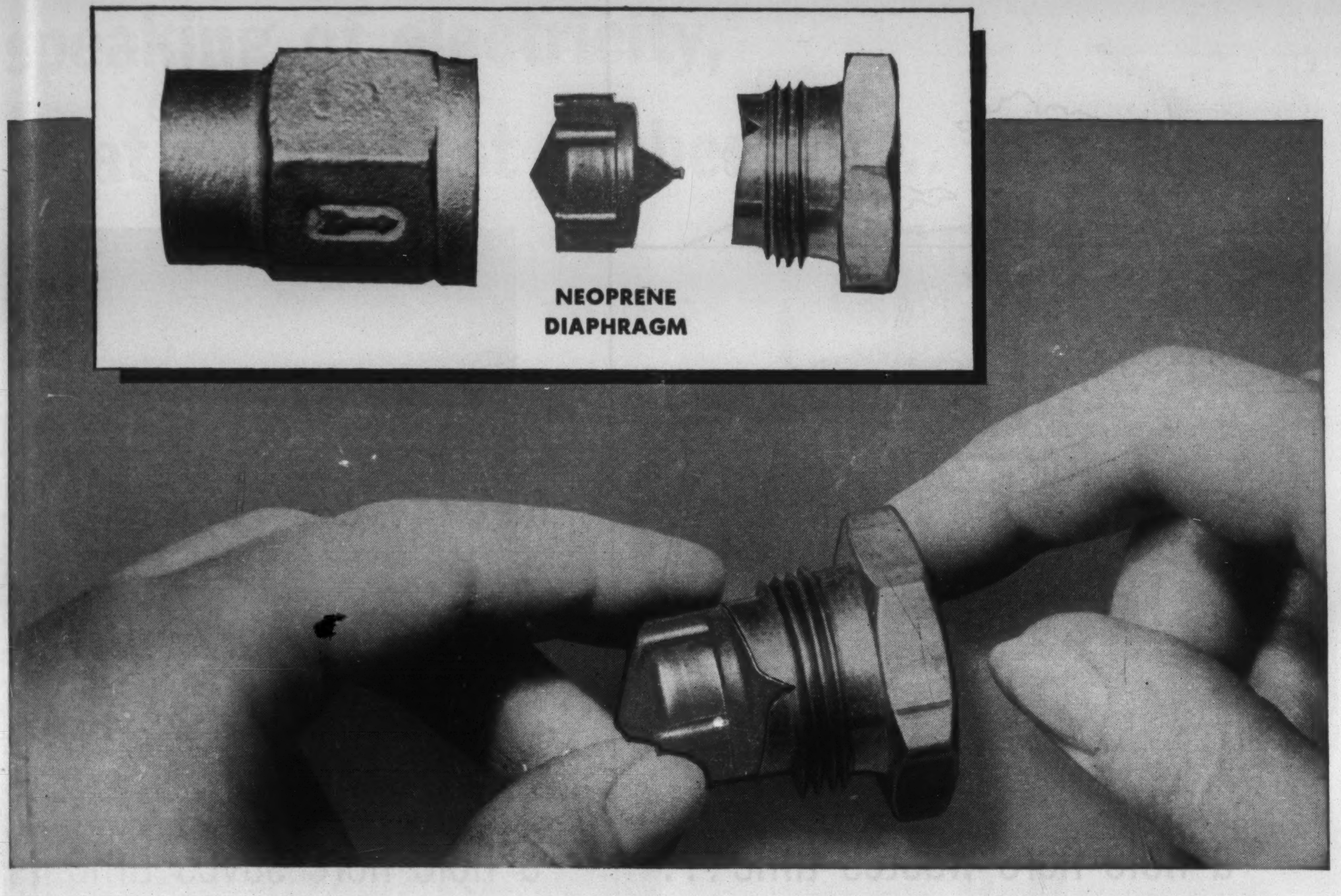

Valve diaphragm of DU PONT NEOPRENE resists water absorption . . . stays flexible, resilient

This improved flow control valve assures a constant rate of water flow despite fluctuating inlet pressures. A neoprene diaphragm, specially compounded for low water absorption and a very stable modulus of elasticity, provides the controlling element in this device.

Designed for drinking fountains, washing machines, dishwashers, and other applications where constant rate of flow is a problem, the valve is simple and effective. Note the broad shallow V cut in the orifice (as well as the more obvious little notch). As inlet pressure increases, the neoprene diaphragm flexes into the broad V of the orifice, reducing the opening and throttling the flow. When pressure decreases, the diaphragm relaxes; the opening is enlarged; and the flow rate remains constant.

The valve is designed to maintain constant rate of flow (within ± 10%) at inlet pressures between 10 and 150 psi. in the temperature range between 50 and 150°F. The valve can be counted on to give dependable service indefinitely—thanks to neoprene, Du Pont's chemical rubber.

Next time your design calls for a resilient material, try neoprene. It has solved countless problems for designers over the years, and you'll find its reputation for trouble-free performance is well deserved.

Remember, of all resilient materials, only neoprene has balanced resistance to:

- Oils, solvents, most chemicals
- Permanent distortion
- Air and gas diffusion
- Abrasion, cutting, chipping
- Low-temperature stiffening
- Sunlight and weathering
- Oxidation
- Heat

NEOPRENE

The rubber made by Du Pont since 1932

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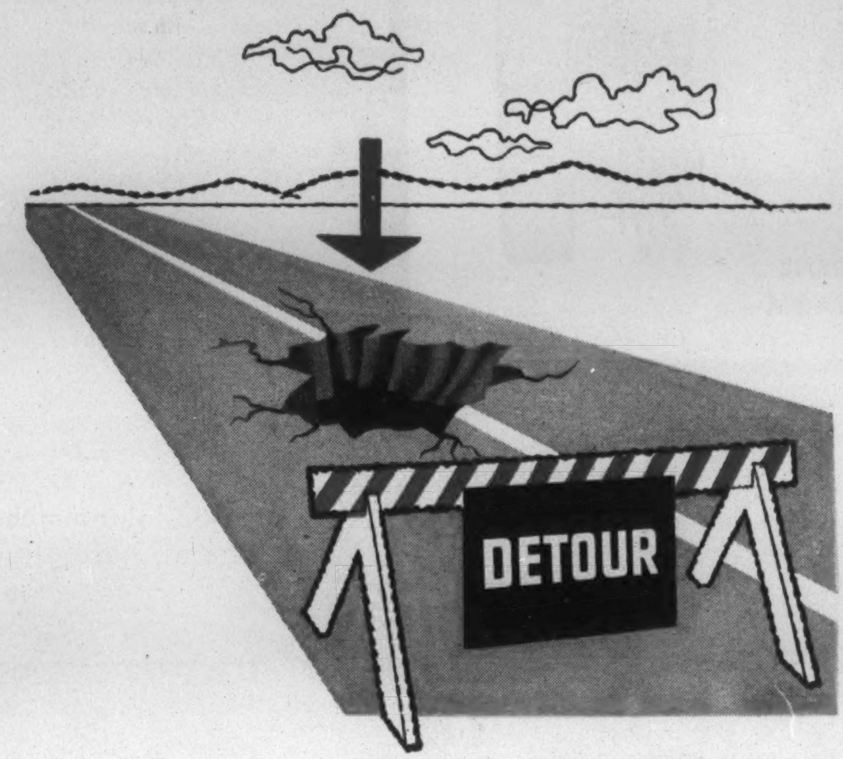

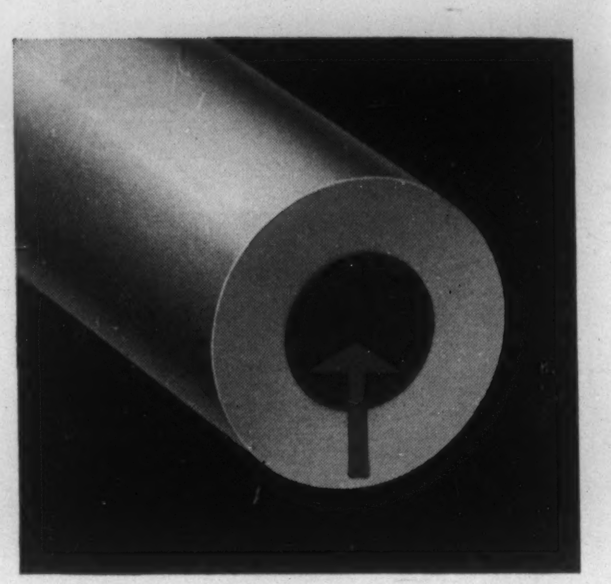

a hole here wastes time . . .

a hole here saves time

Crucible Hollow Tool Steel Bars save time — and money too — whenever you need ring-shaped steel parts, or tools with a center hole. The tool steel is drilled through when you get it! You don't need to bore, drill, hole-saw, cut off or rough-face. That's why they cut your production time, increase machine capacity — and reduce scrap losses.

You can get these hollow bars in any of Crucible's famous quality tool steels, in almost any combination of OD and ID sizes. And you can get *immediate* delivery of five popular grades — KETOS oil-hardening; SANDERSON water-hardening; AIRDI 150 high carbon, high chromium; AIRKOOL air-hardening; and NU DIE V hot-work tool steels — from the Crucible warehouse near you.

Call your Crucible representative for the full story of how these steels can save time and money in your shop. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE **first name in special purpose steels**

Crucible Steel Company of America

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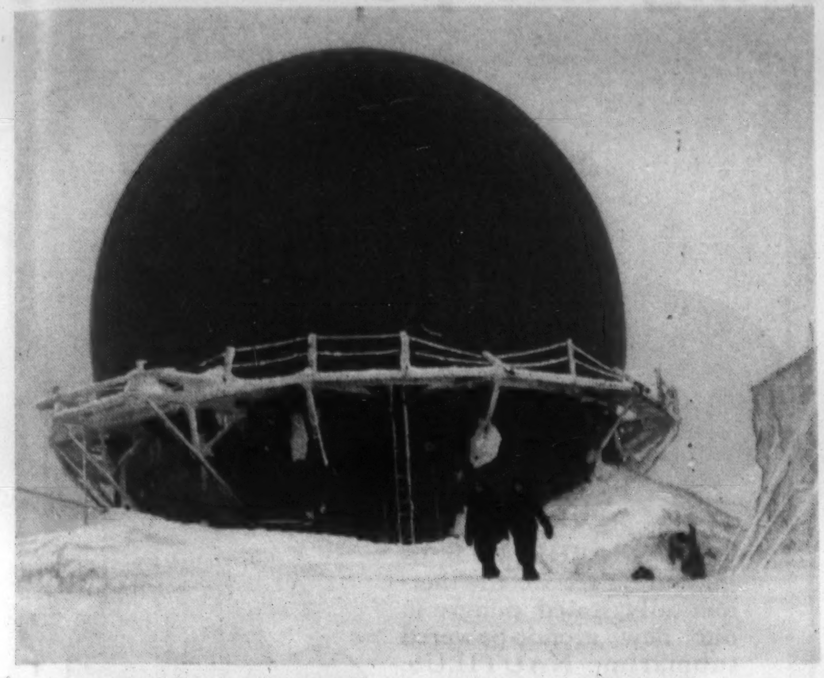
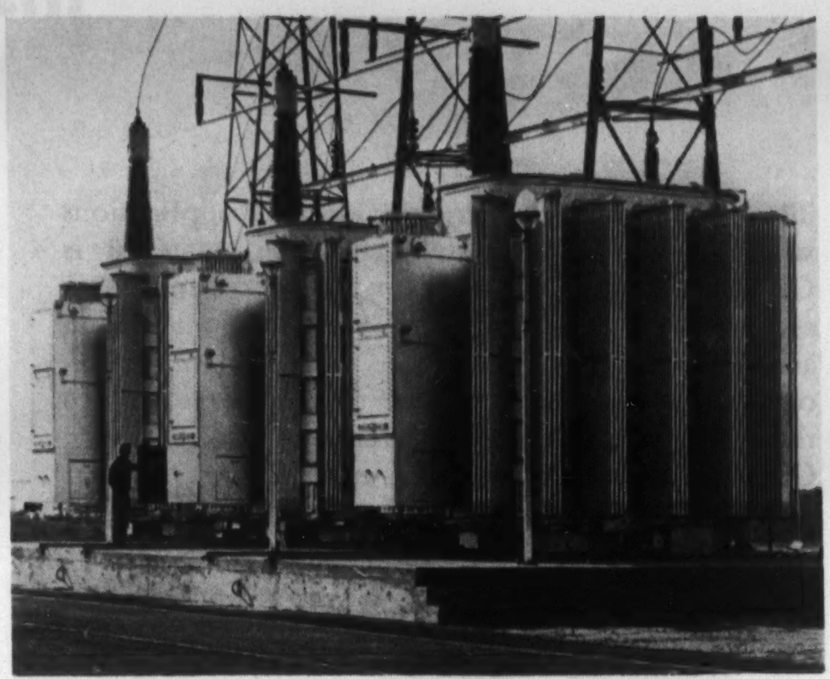
speaking of electricity, what is the best rubber for...

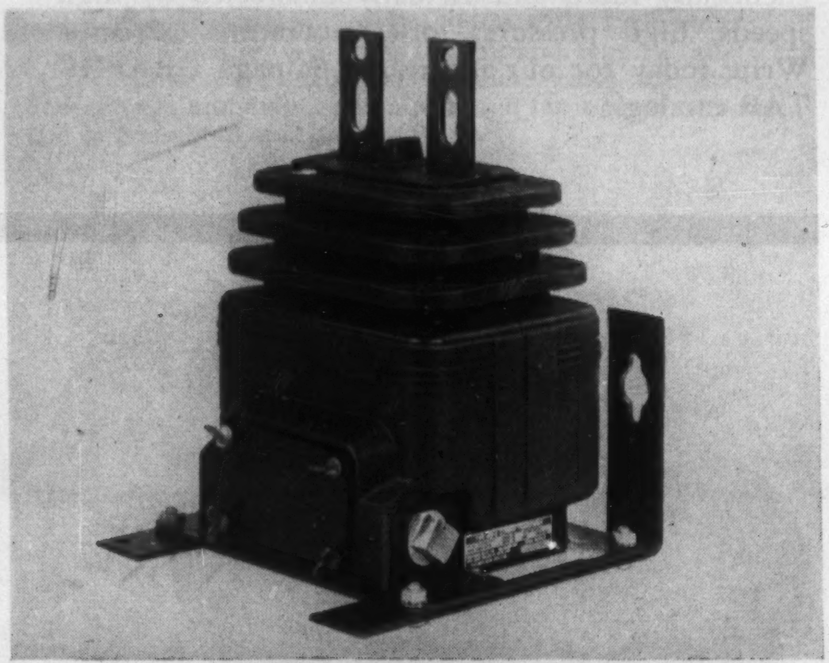


AN ARCTIC RADAR INSTALLATION?...



A HIGH-VOLTAGE POWER STATION?...

AN UNDERGROUND SERVICE CABLE?...



A DUAL-PURPOSE TRANSFORMER CASE?...

Enjay Butyl is outstanding for all!

Enjay Butyl retains flexibility to allow radar screens to operate at subzero temperatures. Enjay Butyl's superior resistance to corona and ozone gives better performance with high-voltage cables. Enjay Butyl can withstand high internal heat without becoming brittle, making it ideal for use in underground service cables. And Enjay Butyl's excellent electrical properties and all-weather durability enable it to perform the dual function of insulator and casing for a transformer.

That's why the use of Enjay Butyl in the electrical industry is expanding. To find out how these and other advantages of Enjay Butyl can improve your product, contact the Enjay Company.

Our technical representatives and laboratories are at your service.

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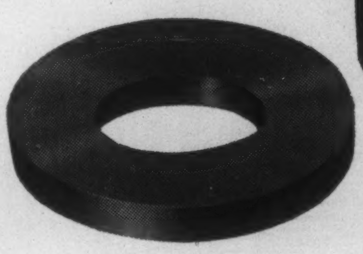
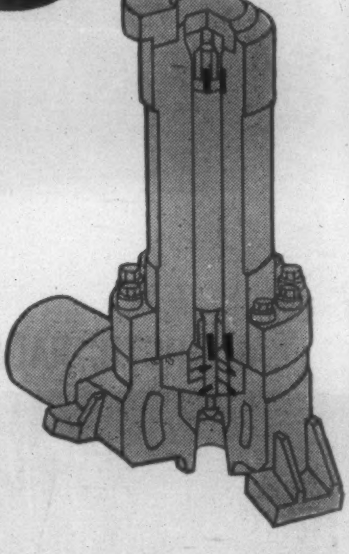
GRAPHITAR® . . . the versatile

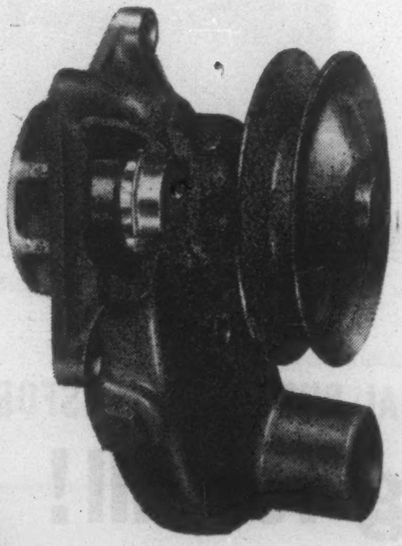
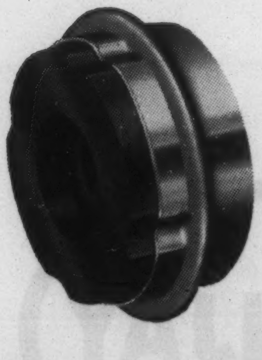
(CARBON-GRAPHITE)

insuring the performance

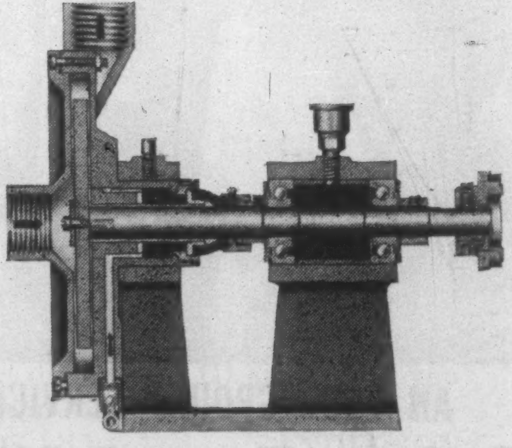
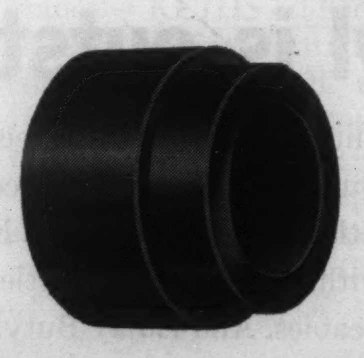
There are literally hundreds of difficult applications where the only completely successful material is GRAPHITAR. It can be used where water and steam are present... in fact, where *only* water and steam are present... because it does not need oil lubrication. It can be used where the temperatures are those of a toaster or the pressures those of a pump. GRAPHITAR is a versatile engineering material produced from carbon-graphite powders, compacted under terrific pressure and fused at heats near 4500° F. It can be formed in relatively complicated shapes and ground to tolerances as close as .0005″ for seals, bearings, vanes, piston liners and many other parts. GRAPHITAR is lightweight, strong and durable, chemically inert, and virtually unaffected by high speeds, high pressures, or temperature extremes. Write today for our illustrated 64-page GRAPHITAR catalog.

These GRAPHITAR bearings are part of the hermetically sealed pumps in our new atomic-powered submarine NAUTILUS. They must withstand high speeds, high temperatures, high pressures, and must operate for indefinite periods of time without maintenance and with radioactive hot water as the only lubricant.

GRAPHITAR is a standard part of this latest type automotive water pump seal. This seal will not leak hot water, cold water, or any type of antifreeze; the wear resistance and chemical resistance of GRAPHITAR insure a seal that will last for the life of the car.

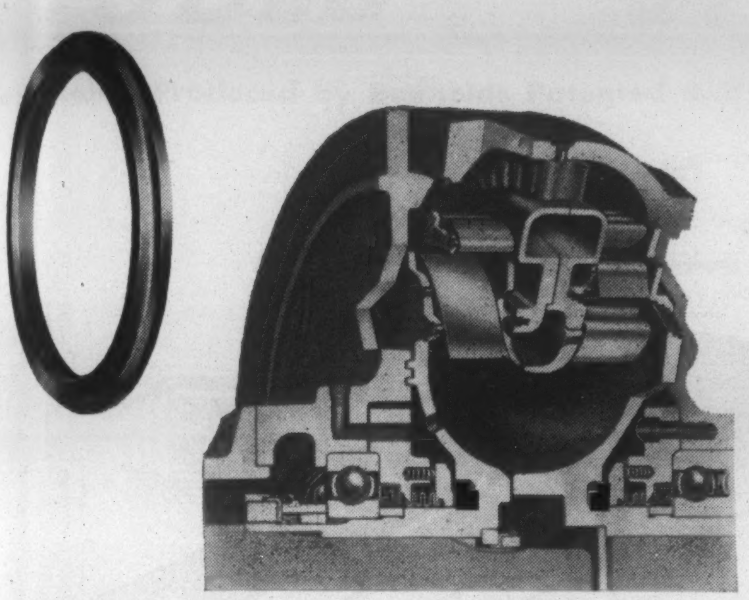



This GRAPHITAR block seal is in a centrifugal type pump that must handle a variety of chemicals and acids. GRAPHITAR resists virtually all chemicals; such potent reagents as Citric and Hydrocholoric acids have no effect on GRAPHITAR.

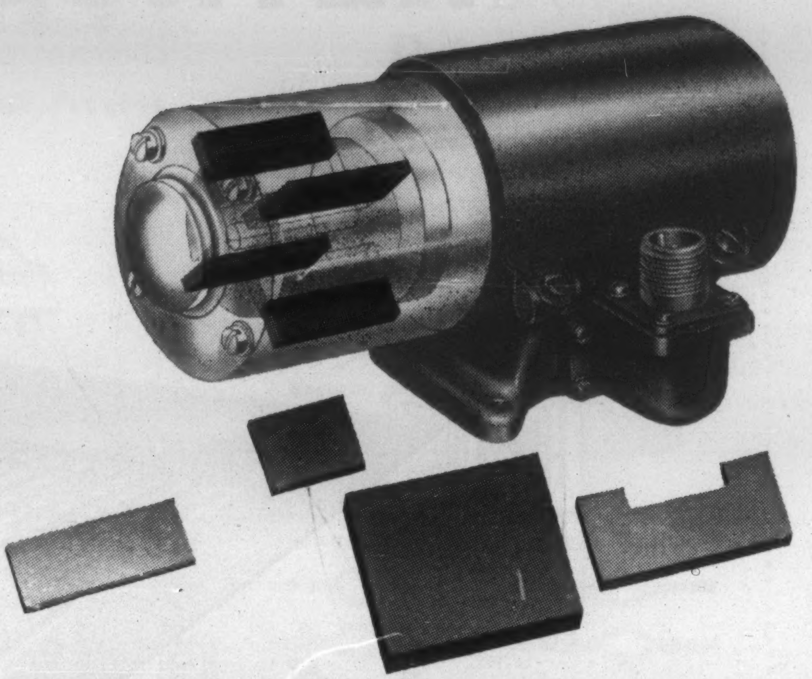
OUR 101ST YEAR

THE UNITED STATES

material that is
# of hundreds of products

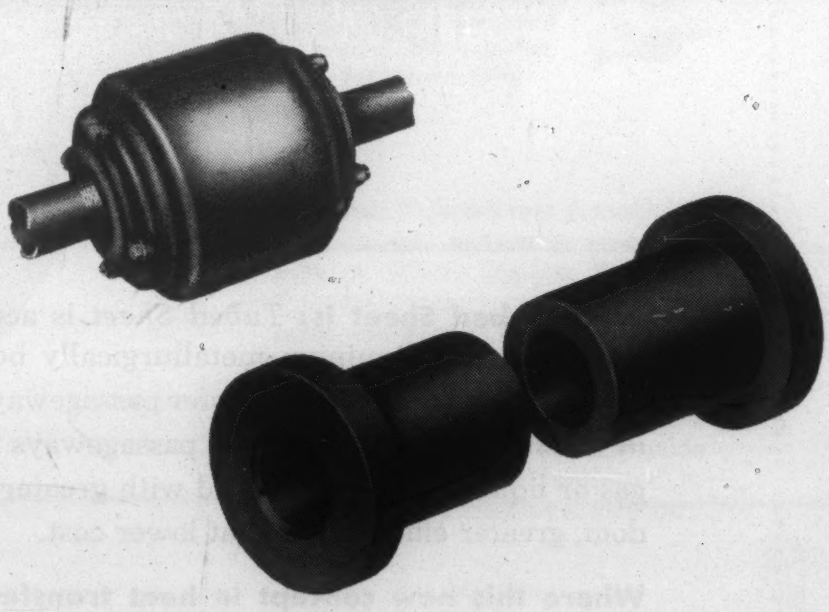


Operating at temperatures up to 350° and 400° F., under pressures of 100 psi and rotating at 1000 feet per minute, GRAPHITAR seals in this industrial torque converter hold a static head and will not gall or leak hot oil. The lapped flat surfaces do not warp or distort.



Rotary pumps, compressors, air motors, vacuum pumps and similar machines equipped with GRAPHITAR vanes function efficiently, give long service, and require little or no maintenance. 25,000,000 of these vanes are now operating in automobiles, in aircraft, in farm equipment, and in household appliances.

These mechanical seals rotate with the shafts of such units as rotary pumps, autoclaves, blowers, etc., to provide a pressure-tight rotary seal. The GRAPHITAR gland insert is ideally suited for this use because it is self-lubricating, chemically inert, and highly resistant to wear.



This pump is essentially an electric motor built around a rotor supported by two GRAPHITAR bearings. It can pump almost any liquid, and the liquid itself is the only lubricant for the GRAPHITAR bearings. The pump is leakproof and needs no oiling.

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

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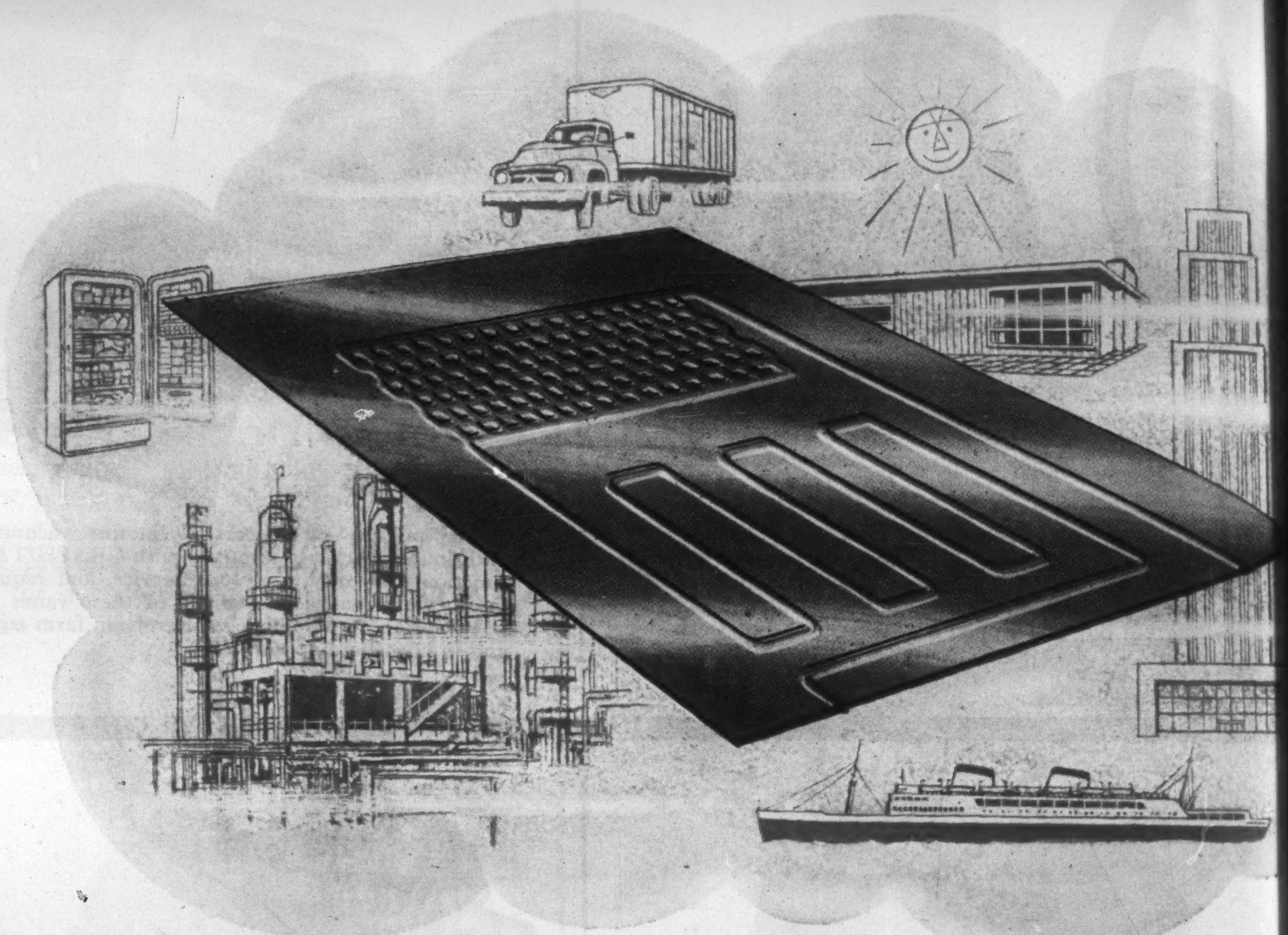
Go ahead and dream! Here's the exciting new material to complement your design and engineering skill!

REYNOLDS ALUMINUM



What Tubed Sheet Is: *Tubed Sheet* is actually two sheets of aluminum metallurgically bonded together so that the heat transfer passageways are *in the sheet.* These expanded passageways route gas or liquid wherever needed with greater freedom, greater efficiency and at lower cost.

Where this new concept in heat transfer applies in transportation, chemical and petroleum, construction and many other industries:

Imagine the possibilities that *Tubed Sheet* offers in *automobile* radiators and air conditioning systems —perhaps even in future radiant heating systems for cars! Or consider *trucks* and *trailers* with refrigerating panels inside roof, sides or floor to surround cargos with constant temperatures! Take *aircraft,* too. De-icing applications in skin of planes; cockpit cooling systems; guided missiles! *Chemical, petroleum* and *petrochemical* industries can benefit from *Tubed Sheet* in air coolers and other heat transfer applications. Radiant heating panel and solar heating systems can bring the advantages of *Tubed Sheet* to the *building* and *construction* industry.

REYNOLDS ALUMINUM

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING

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TUBED SHEET

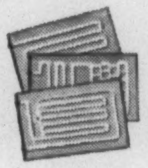
Now Being Produced by Reynolds Patented Roll Bonded Process

And consider this. Already design and engineering men are planning uses for this amazing new material in appliances *other than* heat transfer alone! So go ahead and dream. Reynolds *Tubed Sheet* is the exciting new material that can give *your ingenuity* a chance to really operate!

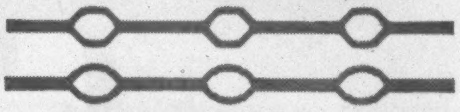
How Performance and Economy Benefits Have Been Proved:

Refrigerator evaporators now being produced by Reynolds for the appliance industry point up the advantages of *Tubed Sheet*. Here are some already proved benefits:

Greater freedom in tubing pattern designs

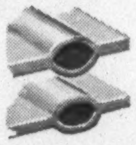


Greater efficiency because there is no loss in conductivity as tubing is integral to sheet



Greater economy through savings in manufacturing operations and in metal

Greater strength because there are no tubes to pull away from sheet—passageways can be flat or oval and placed closer together for extra rigidity



Reynolds *Tubed Sheet* is available with smooth surface or embossed pattern. Where desired, Reynolds *Tubed Sheet* parts can be furnished color anodized in a variety of eye-appealing colors.

Get full details on Reynolds *Tubed Sheet* now. Contact the Reynolds office listed under "Aluminum" in your classified telephone directory or . . .

Write

REYNOLDS ALUMINUM
FABRICATING SERVICE
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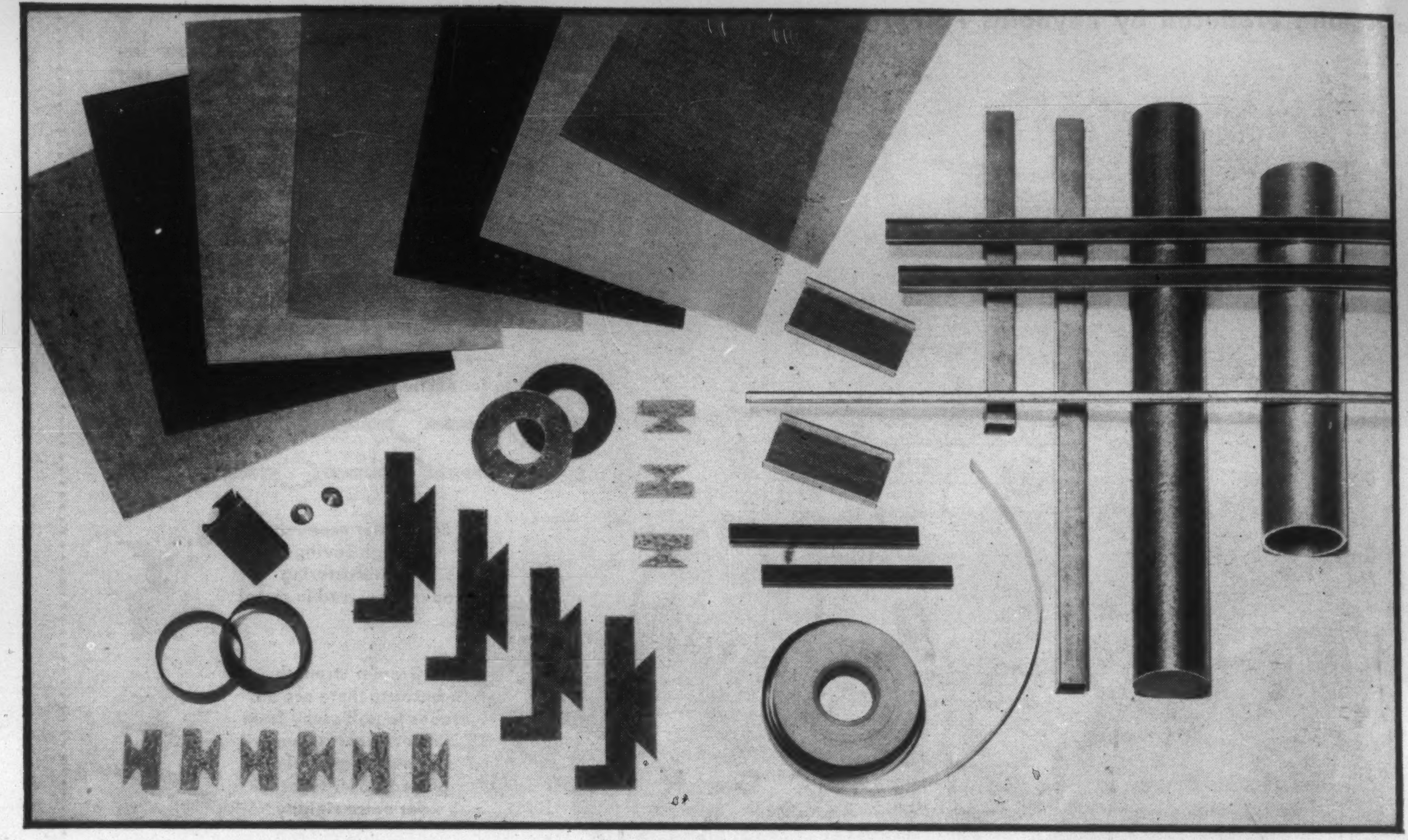
FABRICATING SERVICE

ROLL SHAPING • TUBE BENDING • WELDING • BRAZING • FINISHING

ANNOUNCING **a new system of electrical insulation**



...Micaceous Materials Bonded with Epoxy Resins

MICO, as a result of extensive research, now offers the first epoxy-bonded micaceous insulating materials. These products make available a new, superior system of electrical insulation for generators, motors, transformers and many other applications.

The new materials are epoxy-bonded ISOMICA®: 100% pure mica in machine-made continuous form, impregnated with special epoxy resins. They are available right now in segment plate, molding plate, flexible plate, tapes and tubes.

In epoxy ISOMICA, resins thermoset by addition polymerization upon application of heat. Curing may therefore be accomplished more quickly and with lower pressures. Uncured materials may be stored for extended periods without deterioration.

Properly processed, the insulation system will provide the following advantages:

1. **Good dielectric strength, power factor and resistance to arc tracking.**
2. **Void free. Improved thermal conductivity.**
3. **May be supplied in flexible form and cured in application.**
4. **Excellent resistance to thermal cycling.**
5. **Excellent adhesion to copper and other metals.**
6. **Non-corrosive to metals.**
7. **Outstanding mechanical strength and excellent resistance to chemicals, oils and moisture.**

And because the resins are synthetic, the supply of these materials is not dependent on foreign sources.

If you'd like complete information on how these exciting new products can help you improve the performance of your products and lower costs, drop us a line. A MICO Sales Engineer will be glad to call and discuss your application with you.

MICO® ELECTRICAL INSULATION

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WELDMENTS of "T-1" Steel—made with AWS 12015 low hydrogen coated electrodes and without pre- or post-heating — develop the full 90,000 psi yield strength. As a result, lightweight designs are completely safe and reliable.

NEW USS "T-1" STEEL has great potential for reducing cost of pressure vessels

You've heard of Operation "T-1." You've heard how those dramatic tests proved that, when and if higher design stresses are permitted, USS "T-1" constructional alloy plate steel will make possible larger, stronger pressure vessels, vessels that can be built more easily and at lower over-all cost. As a result of Operation "T-1," several major pressure vessel fabricators have requested approval from the ASME to use USS "T-1" Steel in unfired pressure vessels. Why? For mighty good reasons:

"T-1" Steel has a very high yield strength – 90,000 psi minimum – three times that of conventional plate steels now used in pressure vessels. Yet it is extremely *tough* and can withstand high stresses and pressures even at temperatures far below zero. What's more, USS "T-1" Steel remains strong at *high* temperatures up as high as 900 degrees F.

Yet, "T-1" Steel is easy to fabricate. It can be drilled, machined, or cold formed, and welded or flame-cut *without* pre- or post-heating. **"T-1" can make pressure vessels . . .**

LARGER. For a given pressure and shell thickness, the *radius* of a vessel may be increased in direct proportion to the ratio of working stresses. Result: more storage capacity at lower cost.

STRONGER. For a given radius and shell thickness, the *pressure* may be increased in proportion to the ratio of working stresses. Result: vessels for higher pressures at lower cost.

LIGHTER, EASIER TO BUILD. For a given pressure and radius, the shell thicknesses may be reduced, thus permitting larger vessels to be fabricated *without stress relief*. Result: lower fabrication cost.

United States Steel, Room 4751
525 William Penn Place, Pittsburgh 30, Pa.

☐ Please send me your booklet "United States Steel presents T-1" which contains the full story of "T-1" steel.

☐ Have your representative get in touch with me.

Name ....

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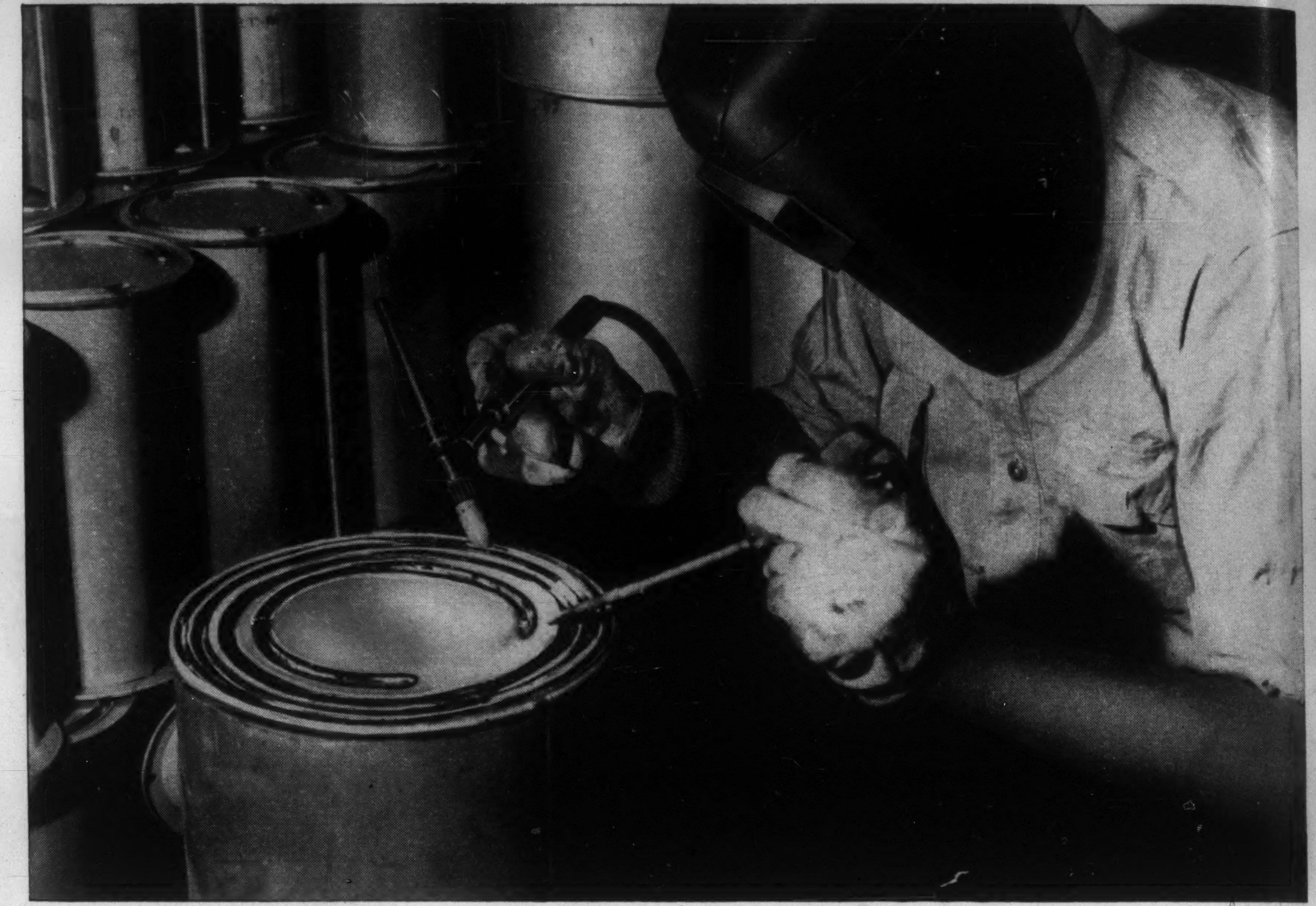
USS "T1" CONSTRUCTIONAL ALLOY STEEL

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL



Multimet alloy wraps are joined by welding in the fabrication of aircraft cabin heaters.

MULTIMET Alloy Wraps
Absorb the Heat from a 3500 deg. F Flame

Multimet alloy wraps are used to absorb the intense heat from burning aviation gasoline in aircraft cabin heaters. The spirally wrapped alloy sheet transfers the combustion heat to fresh ventilating air. Very thin sheet — only 0.025 in. thick—does an excellent job here despite the high metal temperatures and the oxidizing conditions.

Rigorous 1,000-hr. tests were conducted before **Multimet** alloy was selected for this job. It has now been the standard material for seven years. The excellent high-temperature properties of the alloy made it possible for designers to use thin sections, which insure a light, compact heater, with excellent heat-transfer efficiency.

Multimet alloy is one of many **Haynes** high-temperature alloys for economical use over a wide range of operating conditions. It has given good service for engine manifolds, turbine blading, heat-treating equipment and many aircraft components. For a copy of a booklet describing **Haynes** high-temperature alloys, and for prices and sizes of **Multimet** alloy, get in touch with the nearest Haynes Stellite Company office.

HAYNES
TRADE-MARK
ALLOYS

HAYNES STELLITE COMPANY
A Division of Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
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"Haynes" and "Multimet" are registered trade-marks of Union Carbide and Carbon Corporation.

For more information, turn to Reader Service Card, Circle No. 358

For more information, Circle No. 422 ➤

Stainless Steel bulb for color television tube by I-T-E Circuit Breaker Co., Philadelphia, Pa.

Spinning Stainless Steel circles into cone.

Forming cone on 500-ton hydraulic press.

How Stainless Steel helps I-T-E put color into television

Television is opening up a whole, wide wonderful world of color and Stainless Steel is playing an important part in this great advancement. I-T-E Circuit Breaker Company is manufacturing the bulb assembly for color television using cones made from Stainless Steel.

The advantages lie in the light weight made possible by metal shell construction—a highly important consideration at this stage of color tube development—the safety factor of a metal-glass tube and the ability to use a higher-quality glass in the picture surface. Stainless Steel's coefficient of thermal expansion makes it a suitable material for a metal-glass bond.

I-T-E's choice of Stainless Type 430 for its color TV development was a natural as they have produced millions of Stainless Type 430 cones for black and white picture tubes ranging from 8½" diameter sizes to 27" rectangulars.

Stainless Steel's unique combination of properties merits consideration in all types of design problems. And it's not a difficult material to fabricate. Investigate Stainless Steel for your products, and when you do, be sure to use service-tested USS Stainless Steel.

SEE The United States Steel Hour.
It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

FABRICATING FACTS

For the bulb circles of USS Stainless Steel .125" thick are used. Circles are shear formed on a spinning lathe to produce a cone 21" in diameter, tapering to 8" by 14" deep.

Cone is further formed on 500-ton press. Panel is sheared from funnel, flanges are formed and deburred and both parts sandblasted to receive glass.

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USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

Front and rear roof end-caps
Side-panel
Fender molded with rivet holes

In the new IH truck with Metro-Lite body VIBRIN...

for moldable, lightweight strength!

The custom-made Metro-Lite* body places unusually high demands on the materials used. They have to be strong, light, and *easily fabricated*...and where curved components are necessary VIBRIN is used for International multi-stop trucks with these special bodies.

NAUGATUCK'S REINFORCED VIBRIN POLYESTER *IS*...

STRONGER THAN STEEL! Reinforced VIBRIN can actually be made stronger than steel by weight.

LIGHTWEIGHT! Reinforced VIBRIN is one of the lightest materials you can use...helped International attain cut-backs in weight of nearly 800 lbs.

EASILY FABRICATED! Complex, multiple curves are easily molded all in one operation.

DENT-PROOF! Reinforced VIBRIN has unusually high impact strength. And, sections that are subject to heavy road shock or impact damage can be easily strengthened by area reinforcement.

RUST-PROOF, ROT-PROOF! VIBRIN is highly resistant to abrasion, to grease, oil, and most chemicals—it is not damaged by climate or temperature extremes.

STRUCTURALLY STABLE! Reinforced VIBRIN won't warp, shrink, or lose its fit.

EASILY PIGMENTED! VIBRIN parts may be permanently colored. When painted the same color, scratches and chips do not show through.

HIGHLY FINISHED! The finish is imparted by the mold—there is no expensive make-ready prior to painting.

With all these qualifications it's no wonder more and more manufacturers are swinging to VIBRIN®. Would you like to find out how this unique plastic can put *you* on the road to more profits? Write to us on your company letterhead, TODAY!

*A modern lightweight truck body now being produced by THE METROPOLITAN BODY COMPANY, Bridgeport, Conn., subsidiary of International Harvester Co.

Naugatuck Chemical

Division of United States Rubber Company
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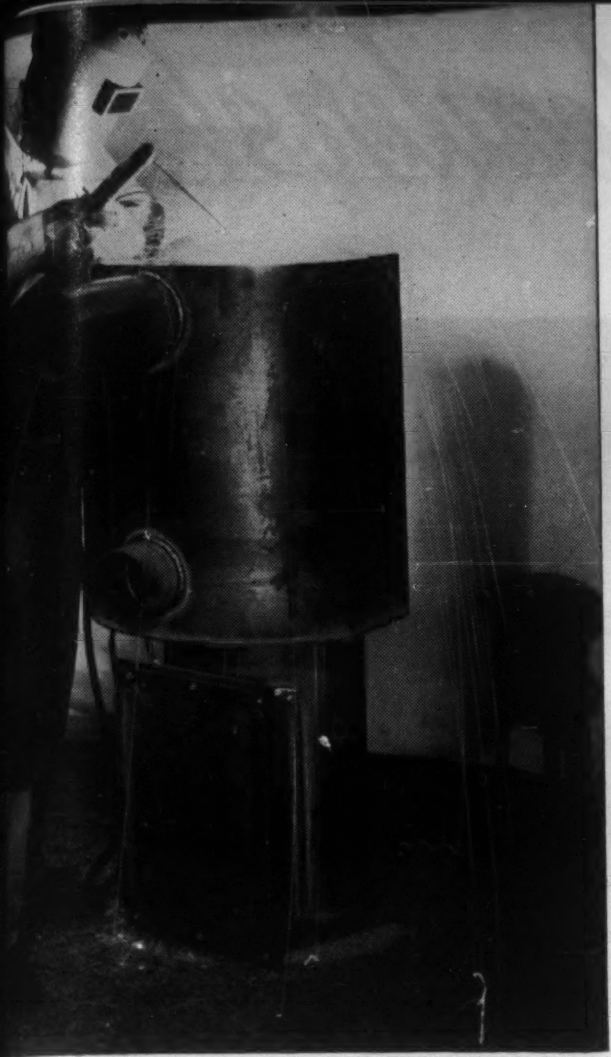
For more information, Circle No. 325 ➤



In this heat exchanger for gas furnaces

Switch to USS COR-TEN Steel extends service life 2 to 3 times

The superior resistance to atmospheric corrosion provided by USS Cor-Ten Steel pays off in several ways for the Hall-Neal Furnace Company, Indianapolis, Ind.

This company makes the Victorgas unit, a heat exchanger for domestic gas furnaces. When built of plain carbon steel these units were quite vulnerable to corrosion, and service life was not as long as desired. Corrosion was encountered when furnaces were down during the summer months. Damage due to condensation of water vapor and the products of gas combustion was particularly severe in intermittent service.

By changing to USS Cor-Ten Steel, which has 4 to 6 times the atmospheric corrosion resistance of carbon steel, it was possible to extend the service life of these units 2 to 3 times. This achievement not only pleases the furnace makers but makes for greater customer acceptance and helps to boost furnace sales.

USS Cor-Ten Steel's ability to form and weld readily, and to safely withstand furnace temperatures up to 1000° F. are other advantages which, added to superior corrosion resistance, far offset its slightly higher cost.

USS MAN-TEN Steel used in portable scaffolds reduces weight 19%,

provides greater strength and durability

These portable work scaffolds manufactured by Baker-Roos, Inc., Indianapolis, Ind., are adjusted and moved more easily, and are more rugged and durable because side rails were redesigned to incorporate USS Man-Ten Steel.

Used by builders, painters, electricians, carpenters and maintenance men in all types of off-the-floor work, the "no X-brace" construction of Baker-Roos scaffolds allows them to span furniture and equipment so that regular production will not be interrupted in occupied areas.

This type of construction and function requires a combination of strength and light weight for maneuverability. To improve the scaffold in these respects, the side rails were changed from carbon steel angles, 1½" x 1½" x 3⁄16", to a section formed from Man-Ten Steel hot rolled strip, .0747" x 5½".

This has reduced side rail weight 19% making it easier to shift the scaffold from job to job. And even though USS Man-Ten Steel is used in lighter sections, the fact that this steel is one and a half times stronger than carbon steel and has 40% higher fatigue strength ensures a stronger and more durable side rail than before.

NOW AVAILABLE . . . Our new "Design Manual for High Strength Steels" is ready for distribution. This excellent book contains comprehensive and practical information that you will find extremely useful in designing your product for greater economy and efficiency by the sound use of high strength steels. For your free copy, write on your company letterhead, giving your title or department, to United States Steel Corporation, Room 4717, 525 William Penn Place, Pittsburgh 30, Pa.

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USS HIGH STRENGTH STEELS

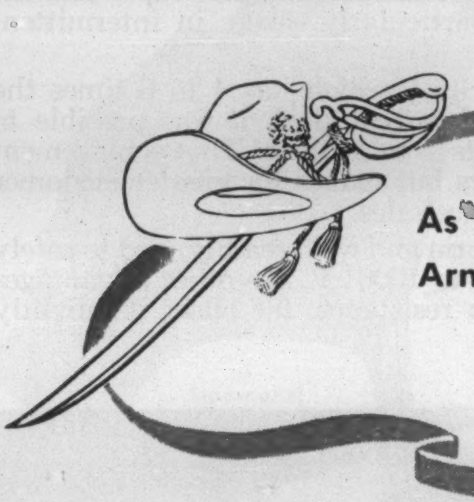
USS MAN-TEN • USS COR-TEN • USS TRI-TEN

UNITED STATES STEEL

Hayes leadership

WORLD'S LARGEST ELECTRIC

with capacity for heating 10 tons of billets for forging



As Maj. General Nathan Bedford Forrest, Confederate Army, said:

"Get thar fustest with the mostest"

WELL, LET'S SEE

The small furnace in the foreground, opposite, is the first controlled-atmosphere furnace ever sold to American Industry.

Guess that's "fustest"

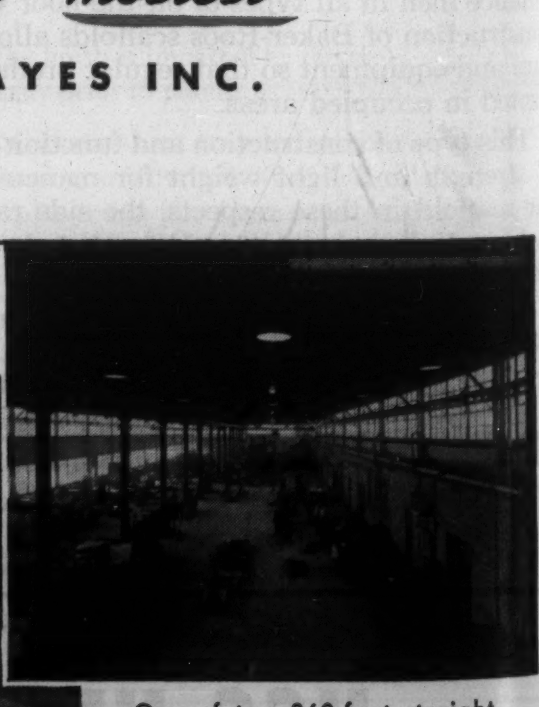
The large furnace is, we believe, the largest high temperature (2400°F.) controlled atmosphere furnace in the world.

Guess that's "mostest"

BOTH DESIGNED AND BUILT BY C. I. HAYES INC.

HAYES' NEW PLANT

Occupied in September, 1954, this plant quadruples our capacity for building "Certain Curtain" furnaces, and facilitates handling of large units like the one opposite.

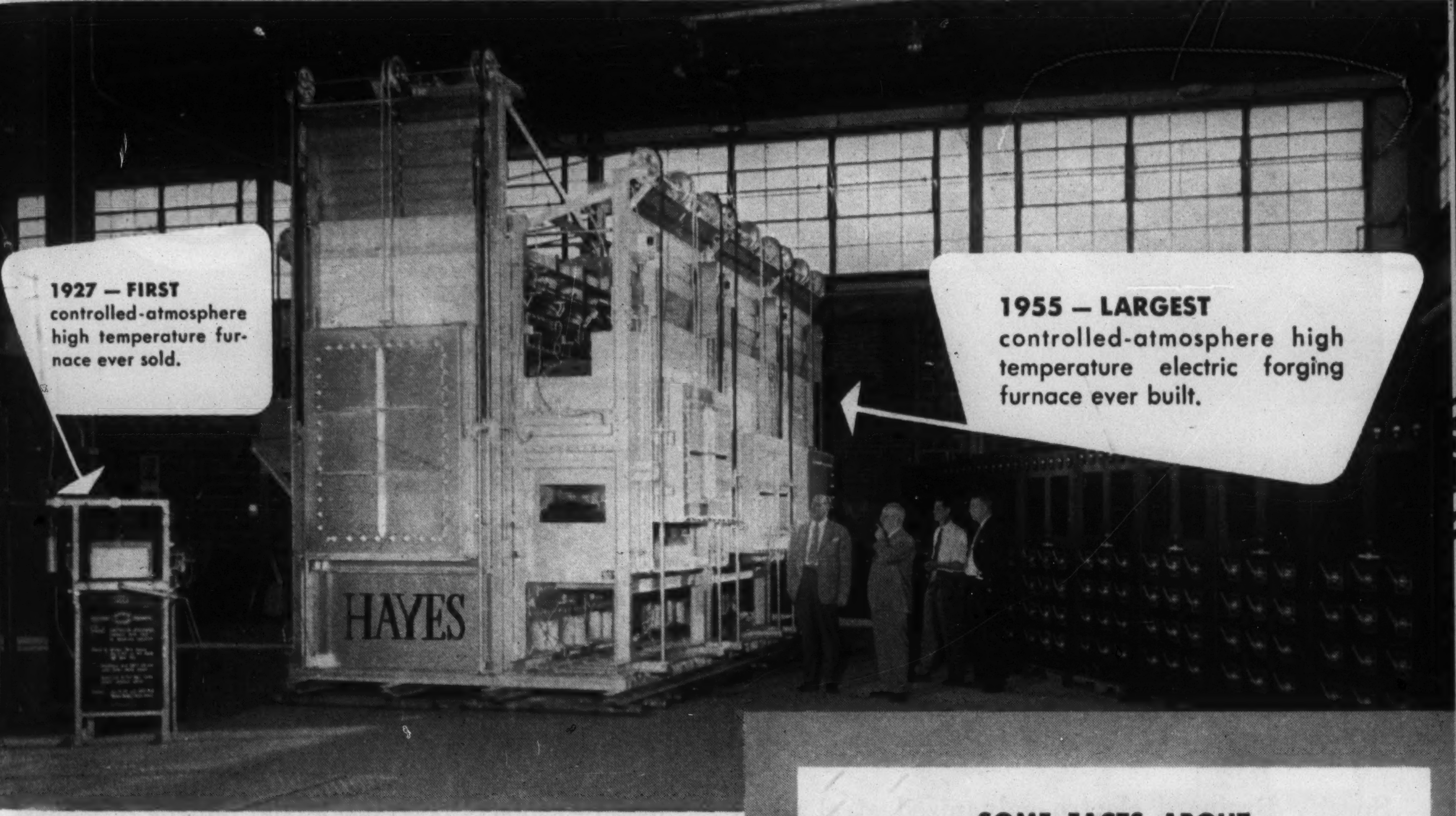


One of two 360-foot straight-through assembly floors, with materials and sub-assemblies feeding in from the sides.

again makes history

STEEL FORGING FURNACE

in the giant 50,000-ton press at Wyman-Gordon Co.



1927 — FIRST controlled-atmosphere high temperature furnace ever sold.

1955 — LARGEST controlled-atmosphere high temperature electric forging furnace ever built.

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ELECTRIC CERTAIN CURTAIN FURNACES
REGISTERED U.S. PAT. OFFICE
CONTROLLED-ATMOSPHERE FURNACES

FOR

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Plus exclusive advanced types of
Atmosphere Generators and Ammonia Dissociators

C. I. HAYES INC.

GOLDEN 50 ANNIVERSARY

891 WELLINGTON AVE., CRANSTON 10, R. I.
For more information, turn to Reader Service Card, Circle No. 476

SOME FACTS ABOUT THIS MAMMOTH FURNACE

Overall dimensions of furnace: 25 feet long, 17 feet high, 13 feet wide.

Gross weight: 55 tons.

Dimensions of heating chamber: 19 feet long, 8' 6" high, 4 feet wide.

Designed to accommodate forgings up to 16 feet in length, weighing up to 10,000 pounds.

Air-operated main loading door at front, plus three air-operated auxiliary loading doors at side all push-button controlled.

Operating temperature 2400 degrees Fahrenheit.

45 Globar heating elements.

Controlled atmosphere throughout heating chamber.

Connected load 600 kilowatts.

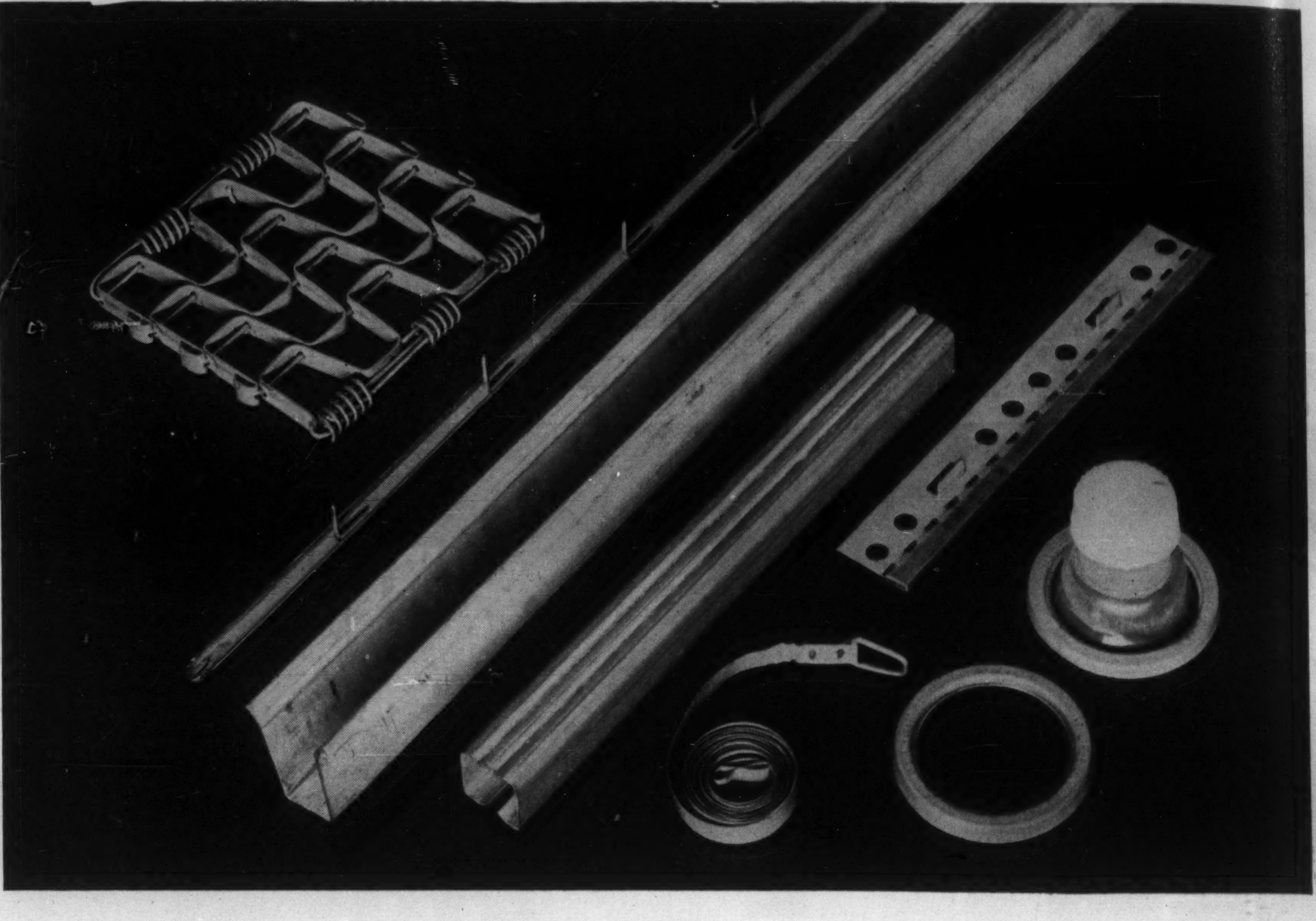
Operation controlled by eight control panels with 90 selective switches controlling the heating elements.

16 Brown electronic temperature controls.

12,000 labor manhours went into its construction.

Shipment was by rail using special "well" car, the largest ever brought into this section.

• BRAINARD ELECTRO-GALVANIZED STEEL



All these parts have a protective coating...

YET REQUIRE NO FINISHING!

Specify Brainard electro-galvanized steel when parts require protection against rust and corrosion . . . you eliminate the coating operation. This pre-coated steel eliminates expensive plating and finishing . . . improves product life and appearance.

The galvanized coating — an integral part of the metal—protects both inside and outside of formed and drawn parts . . . is not affected by forming operations. Coating is hard and uniform, with thickness controlled within .0002.

If your parts require such protection, it will pay you to investigate. Let Brainard quote on your requirements.

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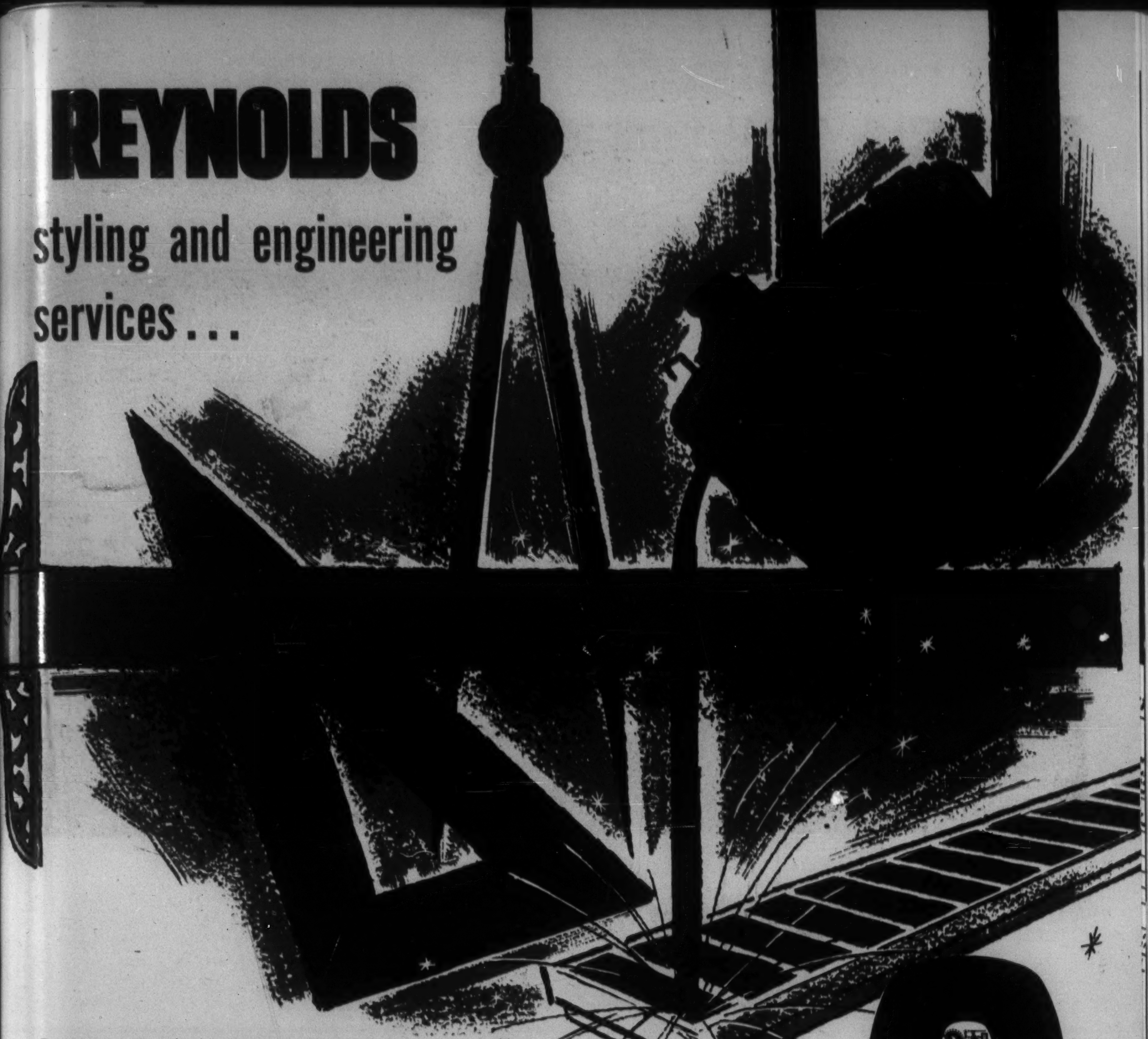

help you get more from the many metals that are aluminum

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A Library of Handbooks filled with important and useful information on aluminum design and fabrication. If your job is management, design or production, these books can be vital to you. Single copies of any or all of these are yours without cost when requested on your business letterhead.

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The Tale of Powdered P
REYNOLDS ME

16mm Sound-Color Films Available, too

❶ **SHAPE OF THINGS TO COME** (extrusion design and application)

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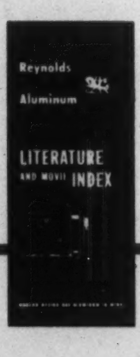
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LITERATURE AND MOVIE INDEX

A COMPLETE INDEX

of all Reynolds Technical Literature and Films on aluminum design and fabrication is also available. Write to Reynolds Metals Company, P. O. Box 1800-HU, Louisville 1, Kentucky.

Instructors in technical schools are also invited to take advantage of these educational aids. Write for details.

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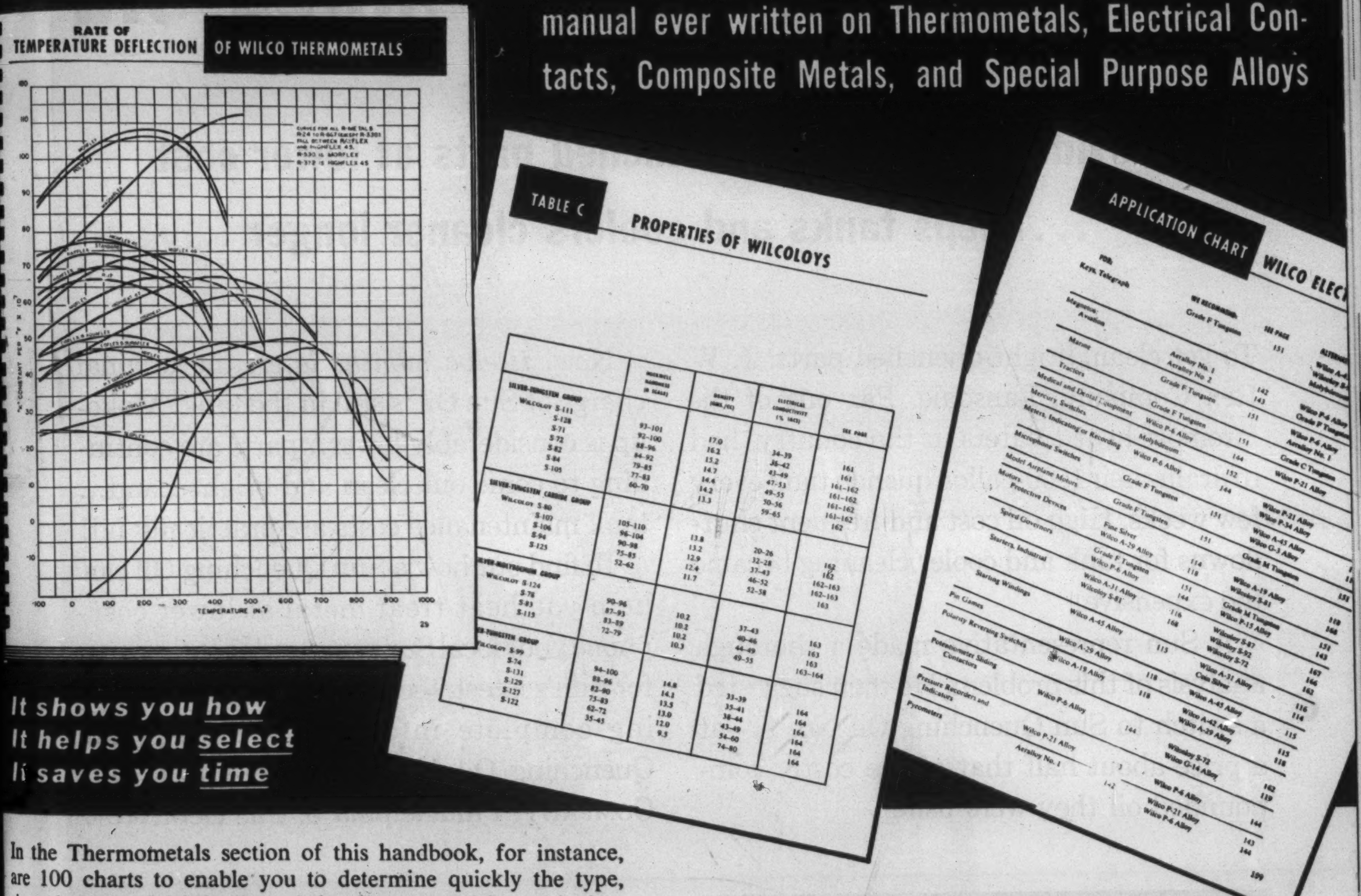
The WILCO Blue Book—the most complete reference manual ever written on Thermometals, Electrical Contacts, Composite Metals, and Special Purpose Alloys



It shows you how
It helps you select
It saves you time

In the Thermometals section of this handbook, for instance, are 100 charts to enable you to determine quickly the type, size, shape, and fabrication of the thermometal best suited to your application. Detailed formulae for estimating the behavior in each application save still more of your time.

In 4 Sections for Ready Reference:

1. **THERMOMETAL** (Thermostatic Bimetals). All temperature ranges, deflection rates, and electrical resistivities,
2. **ELECTRICAL CONTACTS,** including Silver, Platinum, Tungsten and their alloys—Sintered Powder Metals —Precious Metal Laminated Collector Rings.
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4. **SPECIAL ALLOYS:** Ni-Span C Constant Modulus Alloy; other special alloys, including high strength and high conductivity copper base alloys.

This 192-page "Blue Book" is designed with one chief aim—to save you time. There has never been a reference book on these metals remotely comparable to it for completeness. There is no better way to select the correct material than with the Wilco Blue Book combined with Wilco Engineering Service. Qualified personnel may obtain a copy free by writing on their company letterhead. For advice on a specific problem, ask for Wilco Engineering Service.

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. . . keeps tanks and coolers cleaner longer

To get clean, bright-quenched parts, J. W. Rex Company, Lansdale, Pa., one of the foremost heat treaters in the country, had to drain their 1500-gallon quench tank every few weeks. High oil cost and frequent shutdowns for tank and cooler cleaning became too expensive.

A Sun representative made a thorough analysis of this problem. He then suggested a switch to Sun Quenching Oil No. 11—at a price about half that of the costly compounded oil they were using.

Now, *twelve months later*, the original charge of Sun Oil is still in the tank! Make-up is considerably lower…parts are continuing to come out clean and bright…and…tank maintenance costs are practically nil!

To find out how a Sun Quenching Oil can help *you* heat treat metal at lower cost, phone your local Sun representative or write for Sun's latest Technical Bulletin containing complete information about Sun Quenching Oil No. 11. Address SUN OIL COMPANY, Philadelphia 3, Pa. Dept. ML-6

J. W. Rex, right, President of J. W. Rex Co. and Sun representative check brightness of an intricate 8620 steel part after quench in Sun Quenching Oil No. 11.

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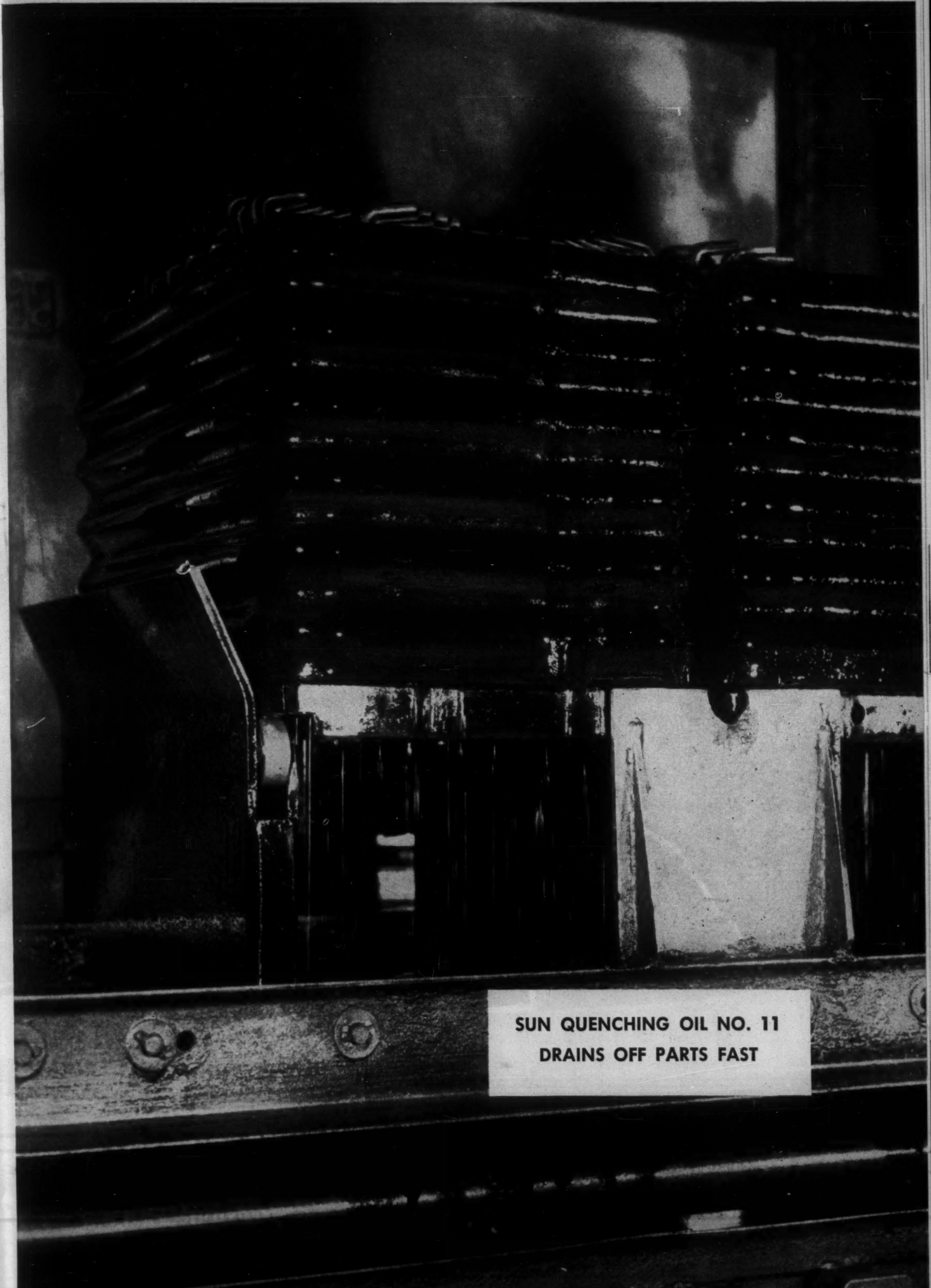
SUN QUENCHING OIL NO. 11
DRAINS OFF PARTS FAST

A new era in the art of forging has been established as production goes forward on this 35,000-ton closed die forging press. Larger forgings with closer tolerances than heretofore possible open new concepts in forging design. Wyman-Gordon continues to pioneer by—*Keeping Ahead of Progress.*

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Established 1883

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STEEL • TITANIUM

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HARVEY, ILL. • DETROIT, MICH.

these parts are made of a material that
offers **unlimited** design possibilities!

● If your product consists of parts that call for unusual physical, electrical or mechanical properties . . . or a *combination* of these . . . you'll find no material more versatile than Star COMMERCIAL WHITE PORCELAIN.

Here is a basic refractory material that possesses great mechanical and high dielectric strength. What's more, it is the most economical type of electrical porcelain for use in the widest variety of applications.

Star COMMERCIAL WHITE PORCELAIN is extremely uniform in color and texture. It is available in both glazed and unglazed form in a wide selection of attractive colors—including the whitest white.

It is particularly suited for wiring device applications such as sockets, switches, fuse blocks, insulators, etc. From a mechanical properties standpoint, its use for fruit reamers, strainers, bottle warmers and novelty items only hint at the unlimited design possibilities of this amazing material.

Why not explore the plus values offered by Star COMMERCIAL WHITE PORCELAIN for your product? Complete engineering data and samples are available without obligation.

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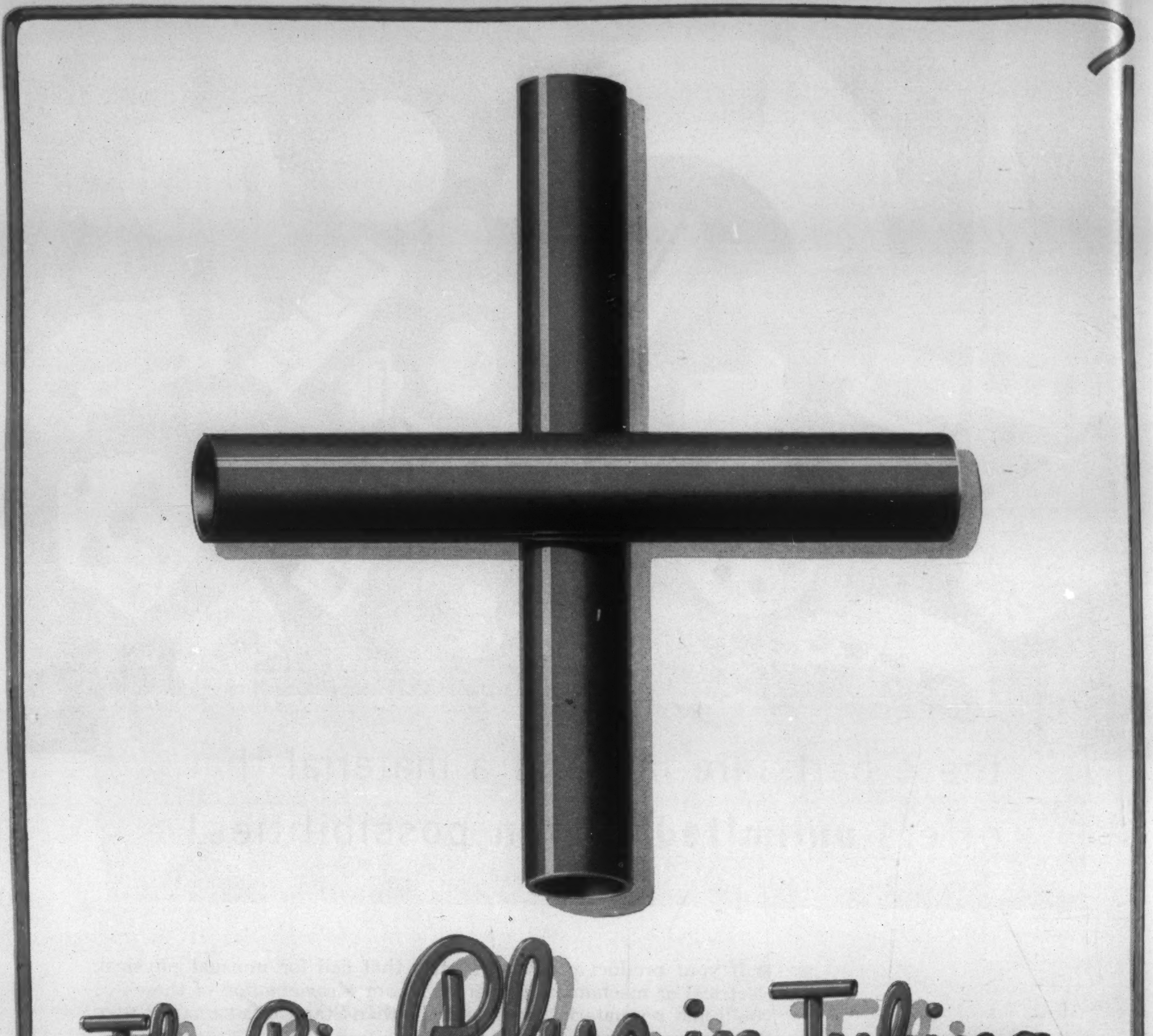
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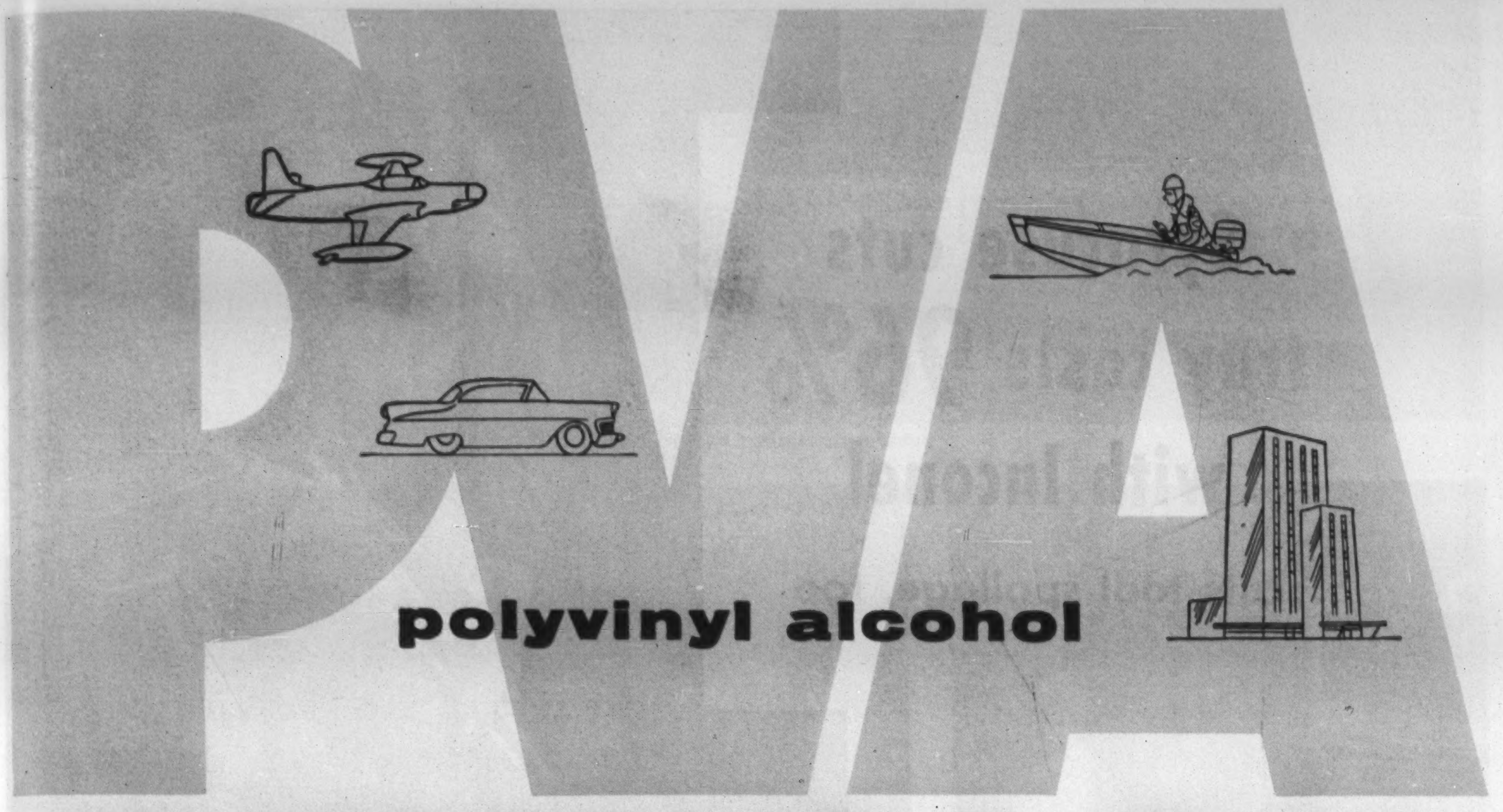


polyvinyl alcohol

REYNOLON

The Quality Plastic Film that offers New Design Freedom, Cuts Costs and Speeds Production of Reinforced Plastic Products

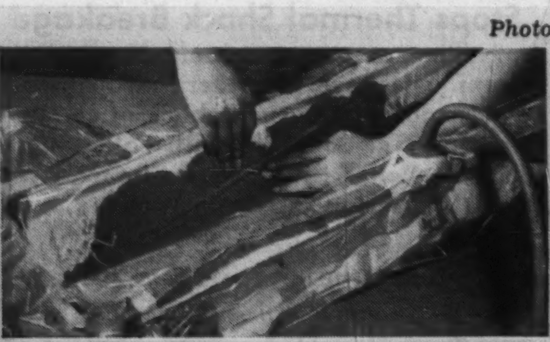
Aircraft, automotive, architectural, boat and many other industries have found bag molding with Reynolon Polyvinyl Alcohol Film permits greater freedom of design, offers economy, and facilitates getting into production quicker on new parts or complete products.

Plastic bag molds can be made faster and at lower cost than matched metal parts. Also – the high elongation characteristics of Reynolon Polyvinyl Alcohol Film as well as its non-inhibiting and clean separating qualities make it ideal in molding reinforced plastics.

Highest quality, clear, strong Reynolon Polyvinyl Alcohol, Polyvinyl Chloride, Polyethylene and laminates of Polyethylene and Cellophane are all available in many standard specifications or can be economically produced for your specialized requirements. Our Technical Product Development Service is also available to you without obligation.

Photos courtesy of Olympic Reinforced Plastics Corp.

Illustrated above is a reinforced plastic layup made on a temporary sectional die and enclosed in Reynolon 4000 Series Polyvinyl Alcohol Film.



Above, vacuum pressure applied by Reynolon 4000 Series Polyvinyl Alcohol Film assures a compact laminate with a minimum of surface voids on mold line.

Illustrated above is the completed component—a reinforced plastic architectural panel—removed from die, trimmed and ready for installation.

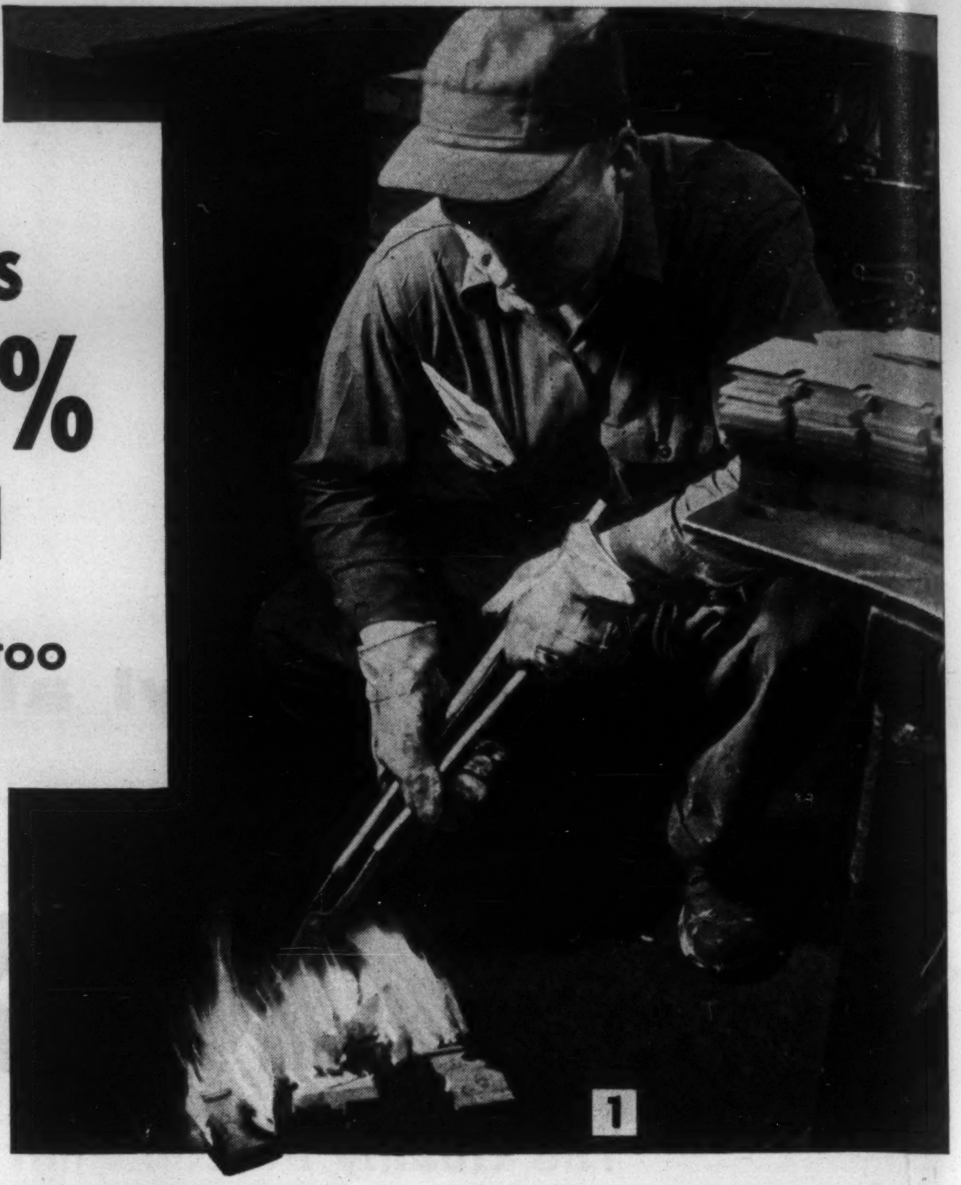
For complete information,
contact your nearest Reynolds Metals Company office or write

PLASTICS DIVISION,
REYNOLDS METALS COMPANY
3804 GEORGIA STREET • GARY, INDIANA

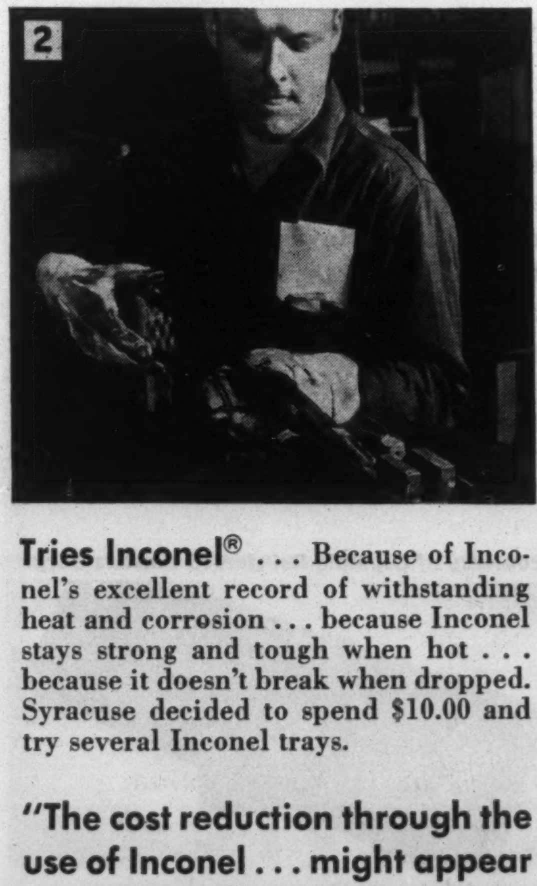
For more information, turn to Reader Service Card, Circle No. 336

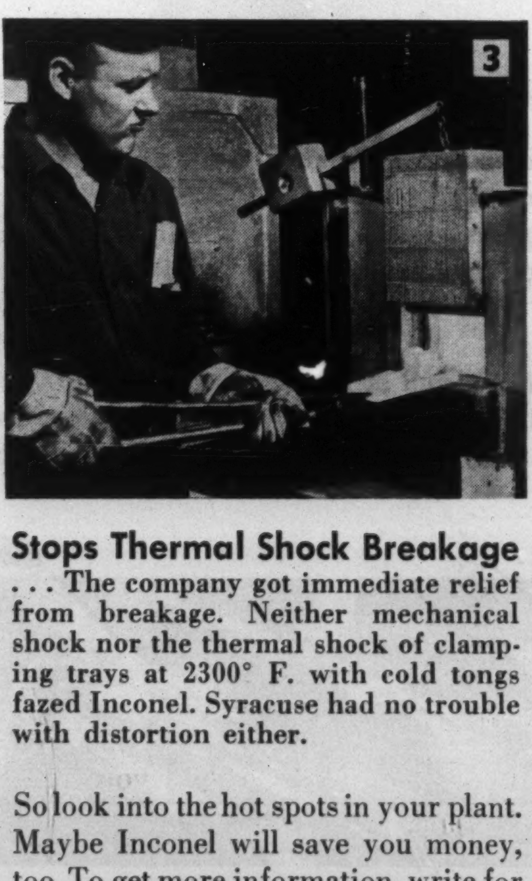
Syracuse cuts tray costs 96% with Inconel

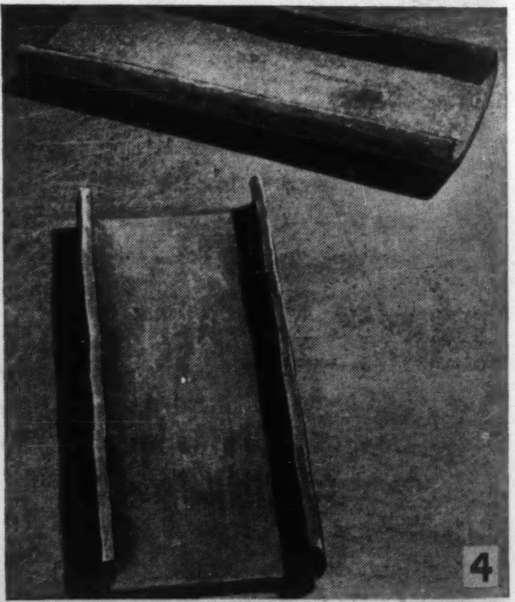
...cuts tool spoilage, too



Breaks trays right and left . . . Nearly every working day, Syracuse Heat Treating Corporation had another silicon carbide tray (costing $3.25 each) broken while heat treating high speed tools. Often they lost four or five tools, as well. In one 5-month period the company replaced 90 broken trays.







Tries Inconel® . . . Because of Inconel's excellent record of withstanding heat and corrosion . . . because Inconel stays strong and tough when hot . . . because it doesn't break when dropped. Syracuse decided to spend $10.00 and try several Inconel trays.

"The cost reduction through the use of Inconel . . . might appear to be fantastic," says Mr. Fred Hunter, General Manager of Syracuse Heat Treating Corporation, but it "is a matter of record."

It's a matter of record in many firms that Inconel saves money in high temperature equipment. And, it's easy to handle . . . readily shaped, welded, and machined.

Stops Thermal Shock Breakage . . . The company got immediate relief from breakage. Neither mechanical shock nor the thermal shock of clamping trays at 2300° F. with cold tongs fazed Inconel. Syracuse had no trouble with distortion either.

So look into the hot spots in your plant. Maybe Inconel will save you money, too. To get more information, write for free booklet, "Keep Operating Costs Down . . . when temperatures go up."

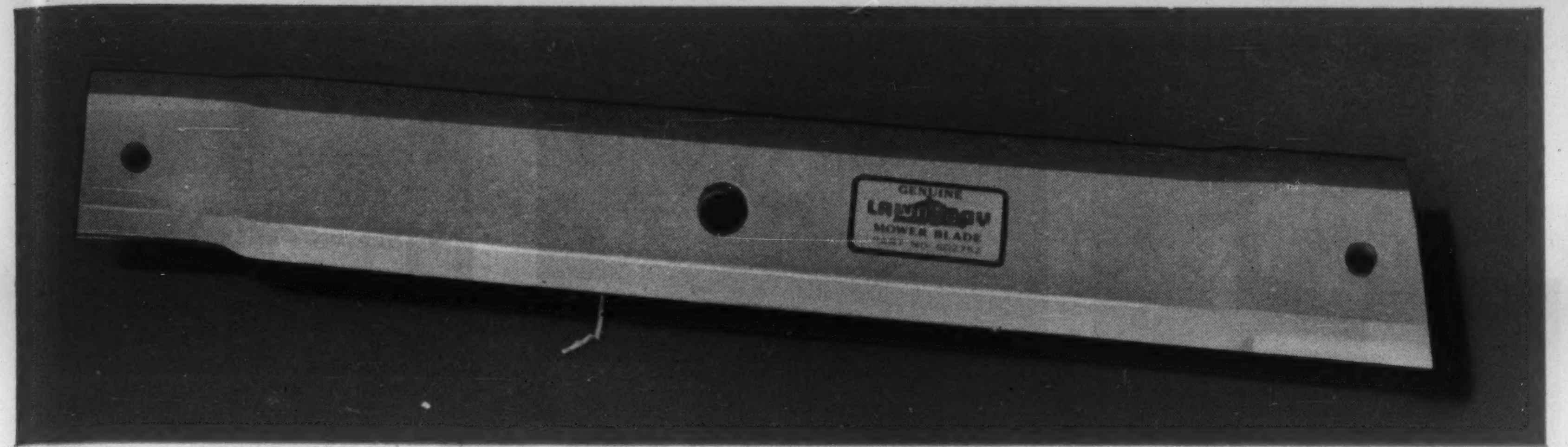
Cuts costs $282.50 . . . plus . . . In the first five months of using Inconel, Syracuse saved $282.50 (96%) in tray costs alone. Tool spoilage went down, too. The company considers that quite a return on its $10.00 investment for Inconel . . . points out (see picture above) that trays have lots more life left.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

NICKEL ALLOYS

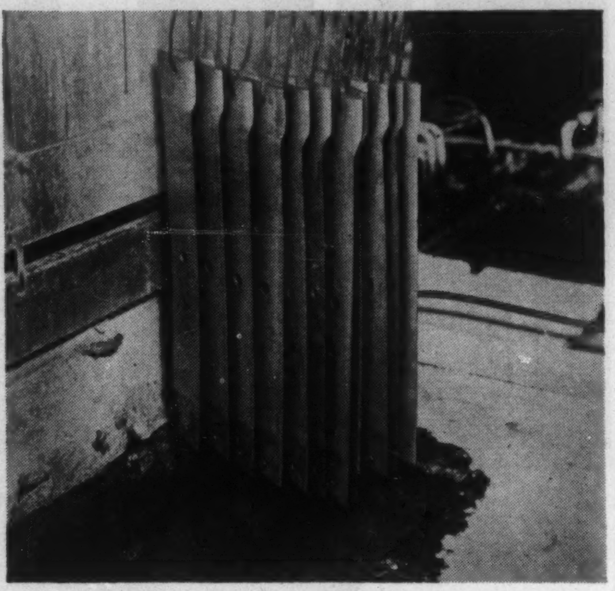
Inconel *for long life at high temperatures*

For more information, turn to Reader Service Card, Circle No. 348



Cutter blade of Crucible alloy steel.

First step in manufacture of cutter blade. Crucible beveled blade alloy steel is fed through this 100-ton press, where it is cut to length and holes punched.



Next, lengths are formed to shape on a hydraulic press, and then given a tempering bath as shown.

CRUCIBLE ALLOY STEEL *cuts blade damage in rotary mowers . . .*

Lawn-Boy mower. Built by RPM Manufacturing Co., Lamar, Mo., a subsidiary of Outboard, Marine & Manufacturing Company, maker of Johnson & Evinrude outboard motors.

Rotary lawnmower cutter blades, whirling at high speeds, often hit small rocks or bits of trash. Ordinary steels just can't take that sort of rugged treatment. They chip, crack — wear out far too quickly. That's why in leading mowers, like the new *Lawn-Boy*, you'll find special *alloy* steel cutter blades *designed for reliable performance.*

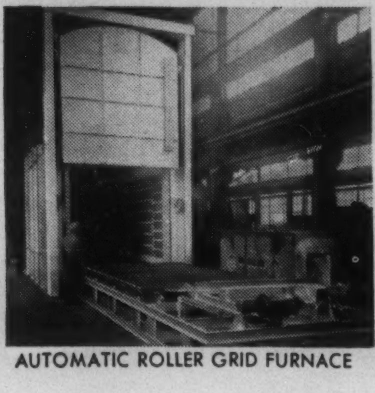
For Crucible has developed a *special alloy steel* made to give the best possible combination of toughness and hardness for long-lasting edges—and formability and ductility for ease of manufacture. It's been so successful that *Crucible is now the largest producer of lawnmower steels.*

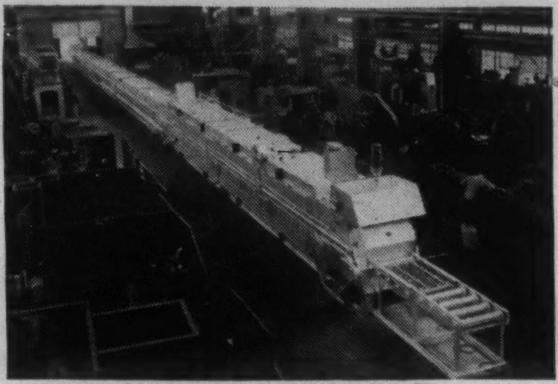
Most Crucible steels are designed to fill *special* needs. If you have an application where ordinary steels won't do, come to Crucible. Take advantage, too, of the dozens of technical booklets and data sheets Crucible has prepared to help you make the best use of special steels. For a free publication catalog, write *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE **first name in special purpose steels**

Crucible Steel Company of America

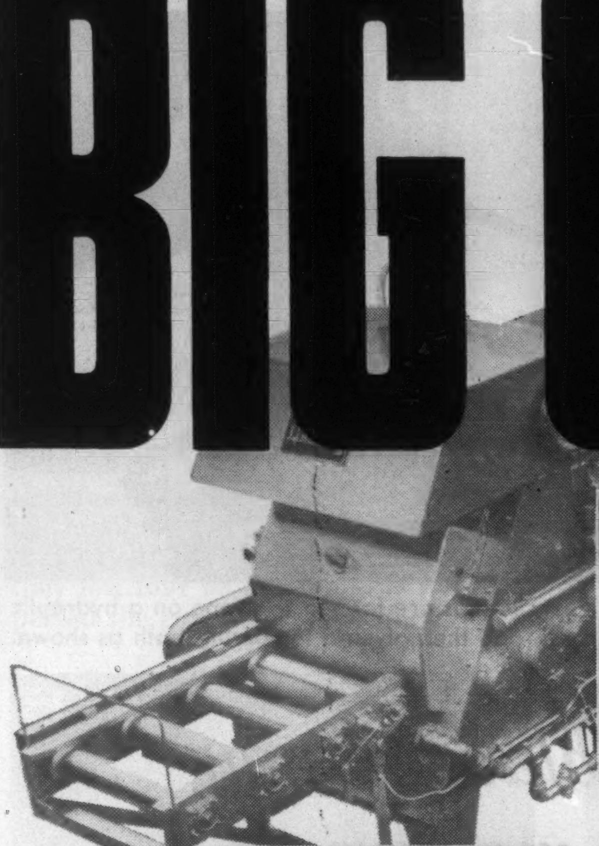
For more information, turn to Reader Service Card, Circle No. 361

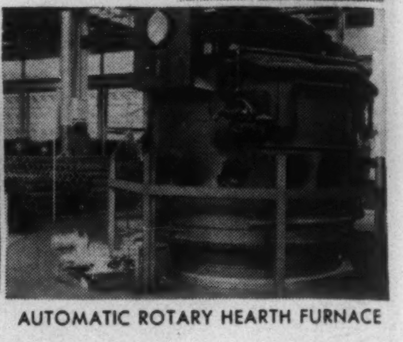

AUTOMATIC ROLLER GRID FURNACE

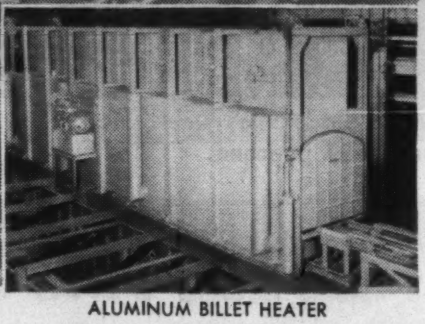

CONTINUOUS ELECTRIC FURNACE

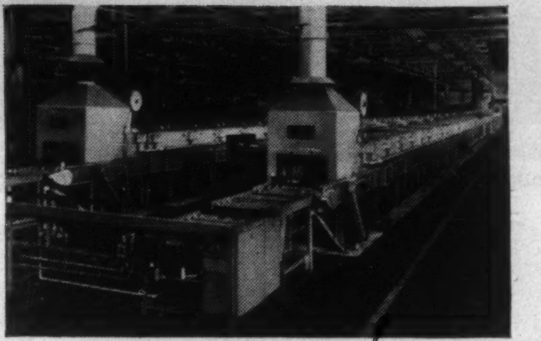
GAS-FIRED ATMOSPHERE TYPE FURNACE

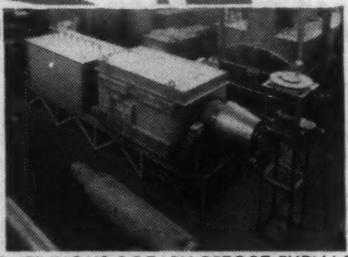
BIG ONES

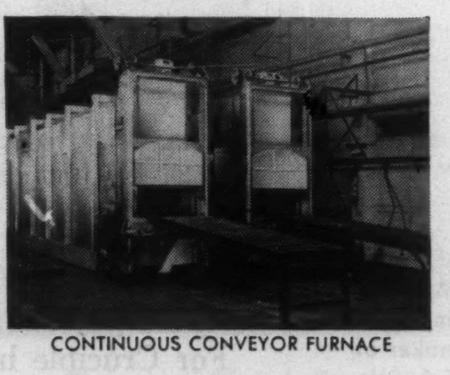


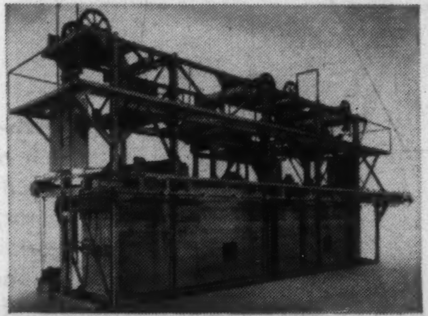

AUTOMATIC ROTARY HEARTH FURNACE

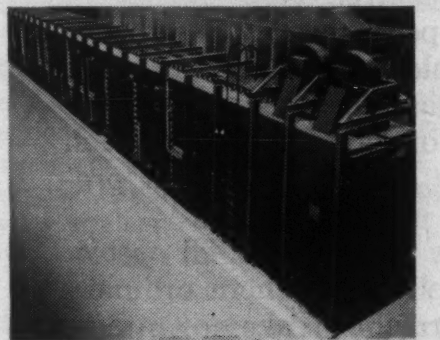

ALUMINUM BILLET HEATER


CONTINUOUS BRAZING PRODUCTION LINES


CONTINUOUS ROTARY RETORT FURNACE


CONTINUOUS CONVEYOR FURNACE


AUTOMATIC HEAT TREATING MACHINE


CONTINUOUS VITREOUS ENAMELING LINE

. . . all field-erected by Lindberg

Maybe you haven't heard the news. Lindberg is now set up to field-erect any type of industrial heating or processing installation. Here are just a few of the large field-erected installations already put up by Lindberg. More are being built right now.

You get a complete package deal from Lindberg. Expert engineers consult with you and analyze your needs. Then they plan and design an installation to meet your specific requirements, whether you need a single furnace or a complete production line. And Lindberg will build it for you, right in your own plant.

To get on-the-spot service from an expert Lindberg engineer, just call your nearest Lindberg Field Office (you'll find the number in the classified section of your phone book, or in the Trade Directories).

LINDBERG INDUSTRIAL

LINDBERG INDUSTRIAL CORPORATION

Chicago Plant: 2321 West Hubbard Street, Chicago, Illinois

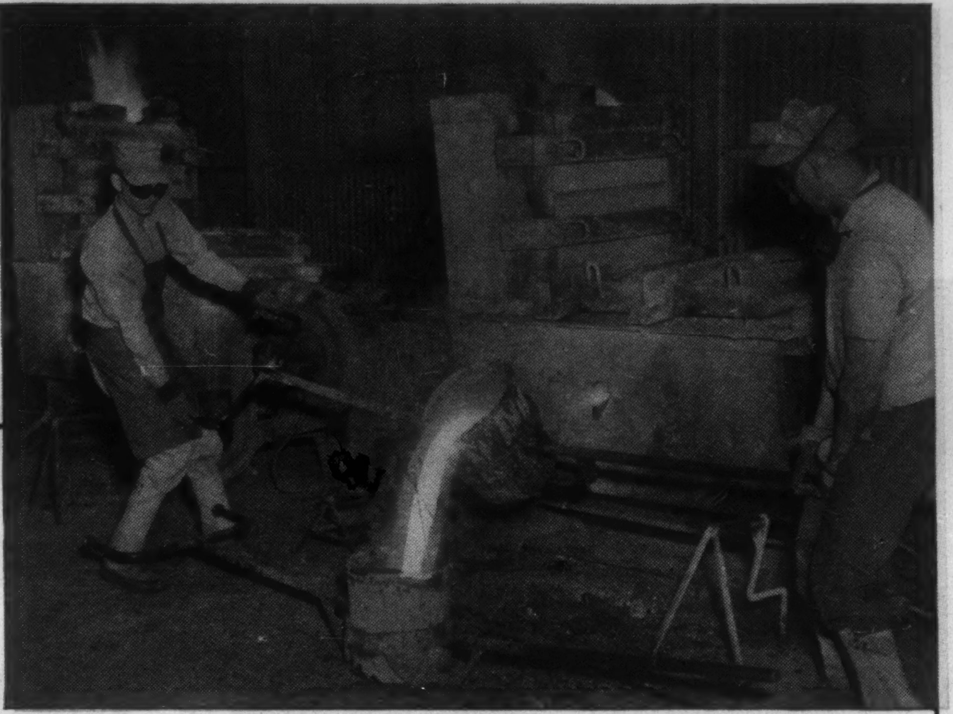
Field Offices in principal cities.

Los Angeles Plant: 11937 Regentview Avenue, at Downey, California
Associate Companies: Lindberg Engineering Company, Chicago • EFCO-Lindberg, Ltd., Montreal • Lindberg Italiana, Milan, Italy

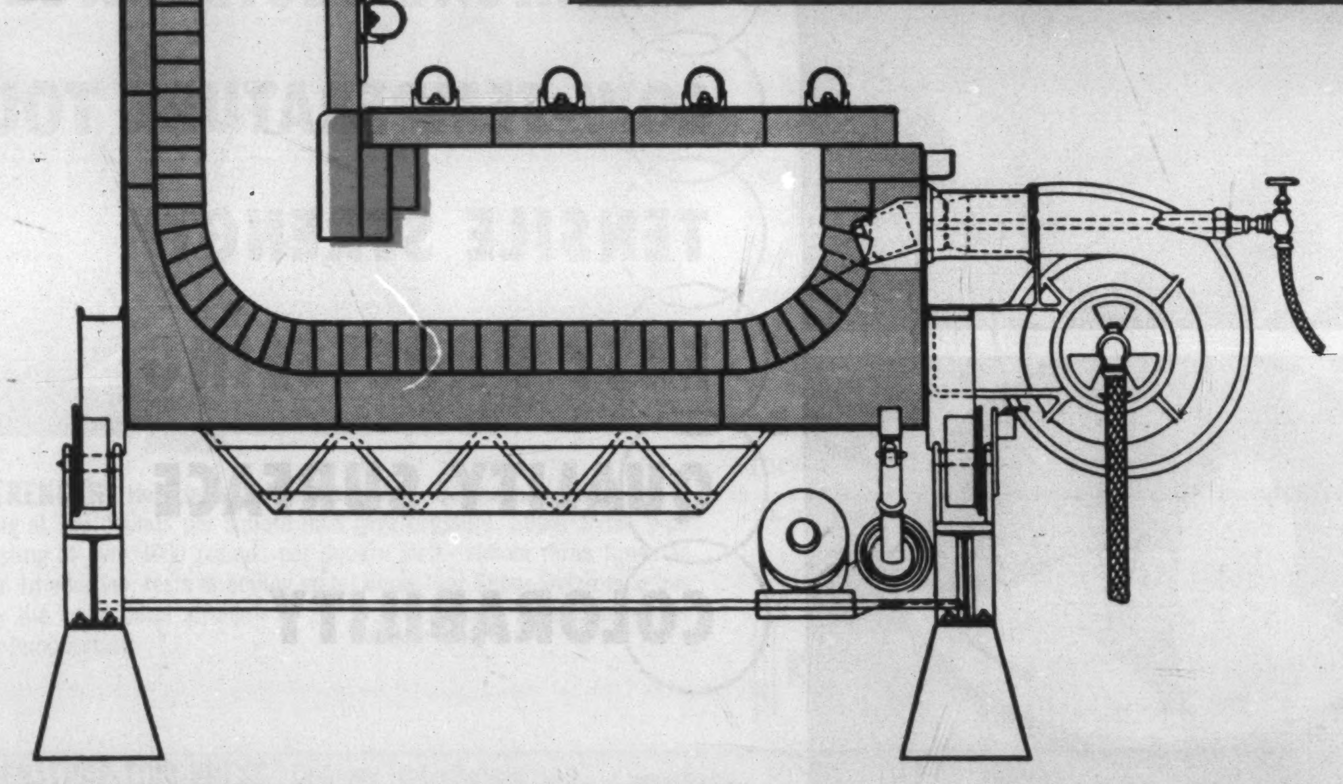
For more information, turn to Reader Service Card, Circle No. 421

Another Norton ℞ *on the job!*

CRYSTOLON baffle plates contribute to the high melting efficiency of Reda reverberatory furnaces*



Reladling ductile iron from a Reda reverberatory furnace for ferrosilicon addition. These furnaces are designed for fast, low cost melting of both ferrous and non-ferrous alloys.



Cross-section of a reverberatory furnace manufactured by the Reda Pump Co. of Bartlesville, Okla. Charge is through the stack and the metal is heated by direct impingement of the flame passing over the metal bath and by reflected heat from roof and side walls. Melting takes place at base of stack, where CRYSTOLON baffle plates (shown in color) are the Norton ℞ — an expertly engineered refractory prescription — for this critical spot.

CRYSTOLON refractory material is *engineered* to combine great physical strength with exceptional resistance to thermal shock, slag penetration and chemical attack. It will withstand temperatures up to 3050°F, and has up to 15 times the resistance of ordinary fire clay to erosion and corrosion.

That is why CRYSTOLON baffle plates were *prescribed* for Reda furnaces — adding another to the long list of highly successful Norton ℞'s for the metal melting field.

Whatever your own furnace operations may be, there is a Norton ℞ that will help you to save time, labor and money. For information about Norton CRYSTOLON*, ALUNDUM*, MAGNORITE* and FUSED STABILIZED ZIRCONIA refractories — standard or special shapes or cements — see your Norton representative. Or write to NORTON COMPANY, Refractories Division, 346 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto 5, Ontario.

NORTON

REFRACTORIES

Engineered... ℞... Prescribed

Making better products... to make your products better

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries.

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Koppers announces

–a revolutionary new molding material

that combines . . .

HEAT RESISTANCE

RIGIDITY

CHEMICAL RESISTANCE

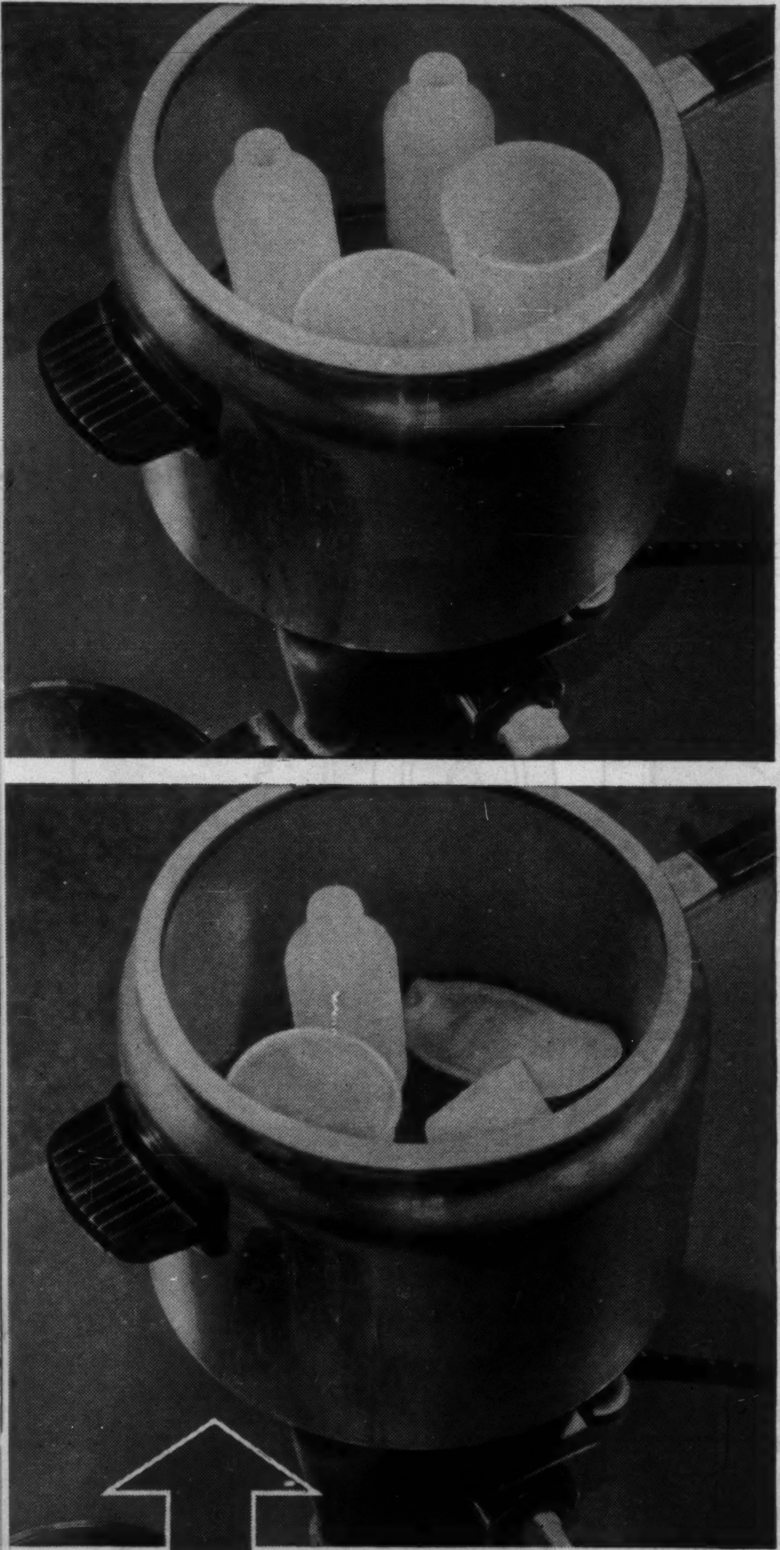
LOW-TEMPERATURE TOUGHNESS

TENSILE STRENGTH

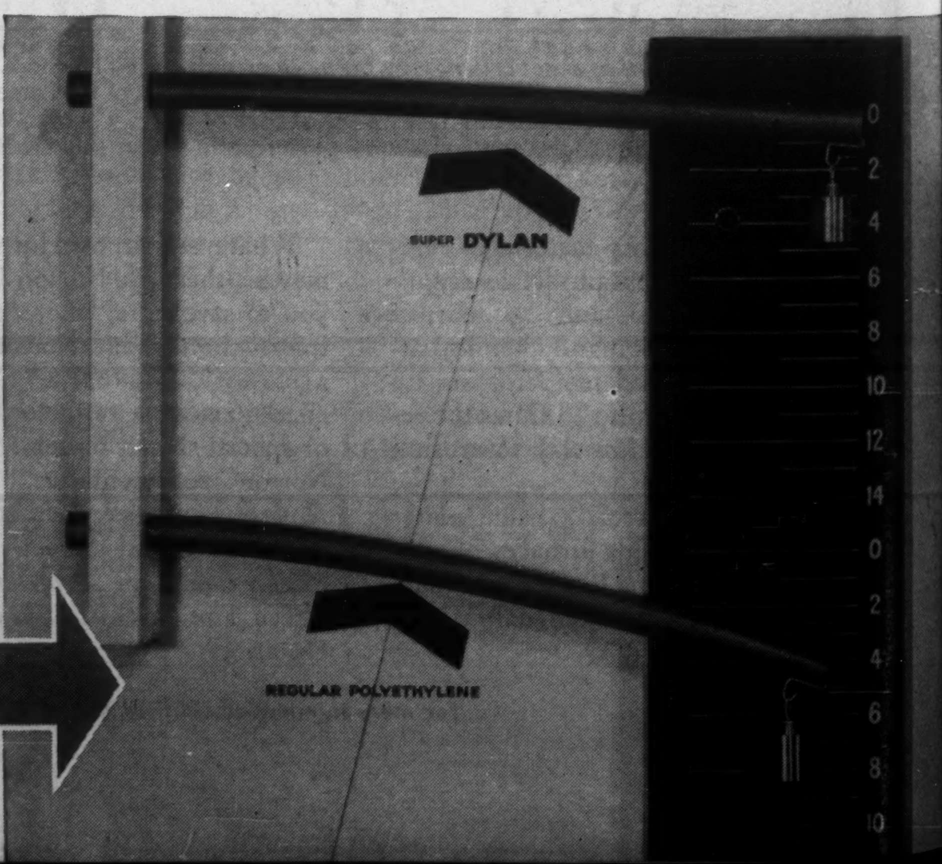
EASY PROCESSING

QUALITY SURFACE

COLORABILITY



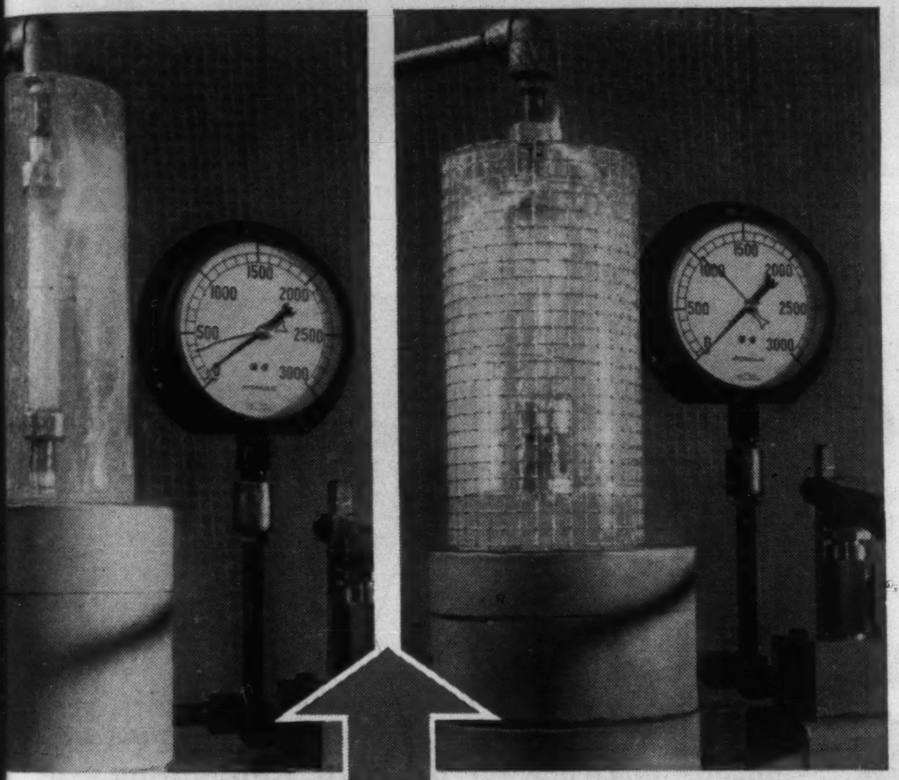
HEAT RESISTANCE Results of pressure cooker test speak for themselves. Cooked for 15 minutes at 250° F., the ordinary polyethylene containers collapsed completely. The Super Dylan containers underwent only a two per cent dimensional change, without deformation and without loss of surface finish.



RIGIDITY These lengths of pipe are mounted only at one end. Identical weights are hung on each. Ordinary polyethylene deflects 5 inches while Super Dylan pipe carries the load easily with only 1¼ inches deflection. In couplings, as well as the pipe itself, Super Dylan Polyethylene has the rigidity, tensile strength, chemical resistance and heat resistance necessary for these applications.

SUPER-DYLAN*

POLYETHYLENE



TENSILE STRENGTH Here is an actual burst test. Ordinary polyethylene is shown bursting at 350 pounds per square inch gage pressure. Super Dylan pipe is shown bursting at over 1000 pounds per square inch—almost three times as great strength. In addition, tests in boiling water show that Super Dylan pipe has approximately the same burst strength at 212° F. as ordinary polyethylene displays at room temperature.

Super Dylan polyethylene, manufactured only by Koppers, opens new avenues of application as a result of characteristics such as greater heat resistance, greater structural stiffness and better appearance than heretofore available in polyethylene. Processing of Super Dylan material is easy. In conventional plastics molding equipment, this new plastic is well within the normal range of molding temperatures. The end product is smooth, glossy—really beautiful in appearance. What's more, a wide range of colors is possible.

With its improved properties, Super Dylan polyethylene should be excellent for applications such as toys, kitchen ware, radio housings, steering wheels, pipe and fittings, bottles and carboys, packaging films, washing machine agitators, refrigerator parts and battery cases.

Investigate Super Dylan polyethylene—discover what its unique combination of properties will mean to your products.

*Koppers trademark

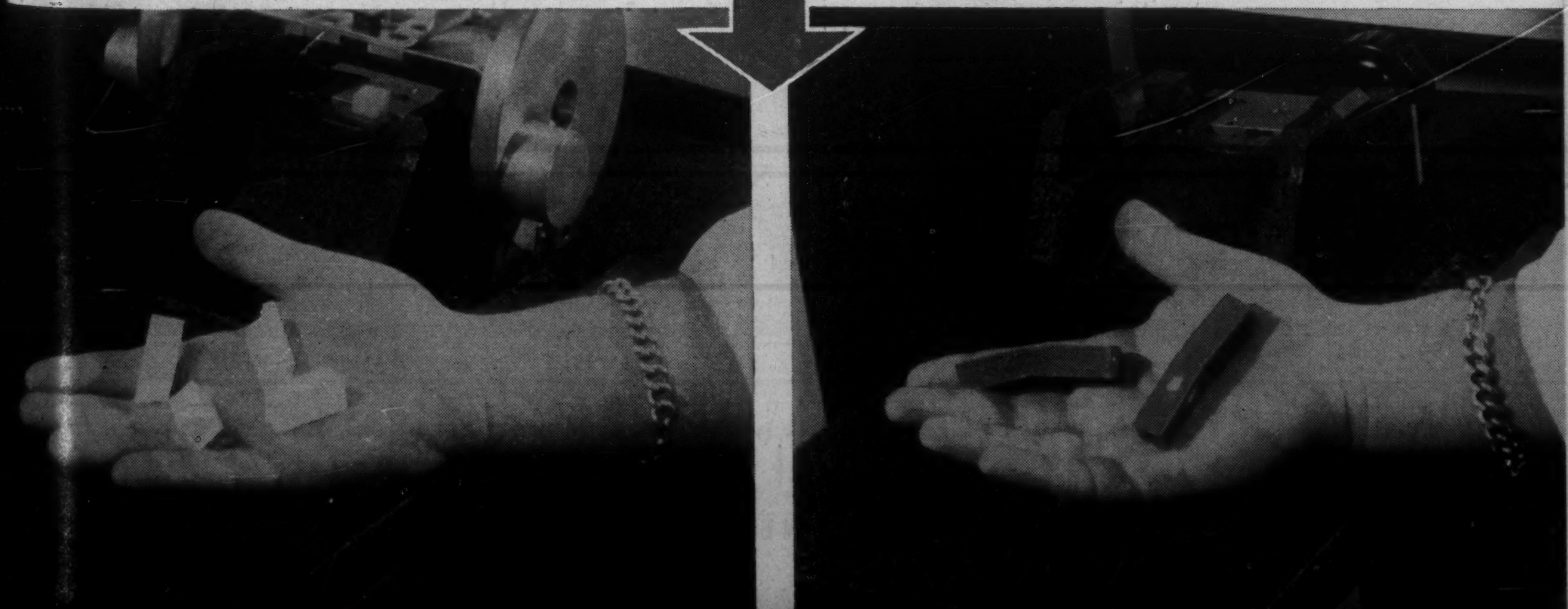
LOW-TEMPERATURE TOUGHNESS Ordinary polyethylene and Super Dylan samples were placed in dry ice overnight. They were then placed in an Izod Impact Tester. At the bottom of its swing, a heavy pendulum strikes and either stops or breaks the sample. Ordinary polyethylene broke—Super Dylan material remained unbroken.

KOPPERS ®

KOPPERS COMPANY, INC.
Chemical Division, Dept. MM-65
Pittsburgh 19, Pennsylvania

For more information Circle No. 473

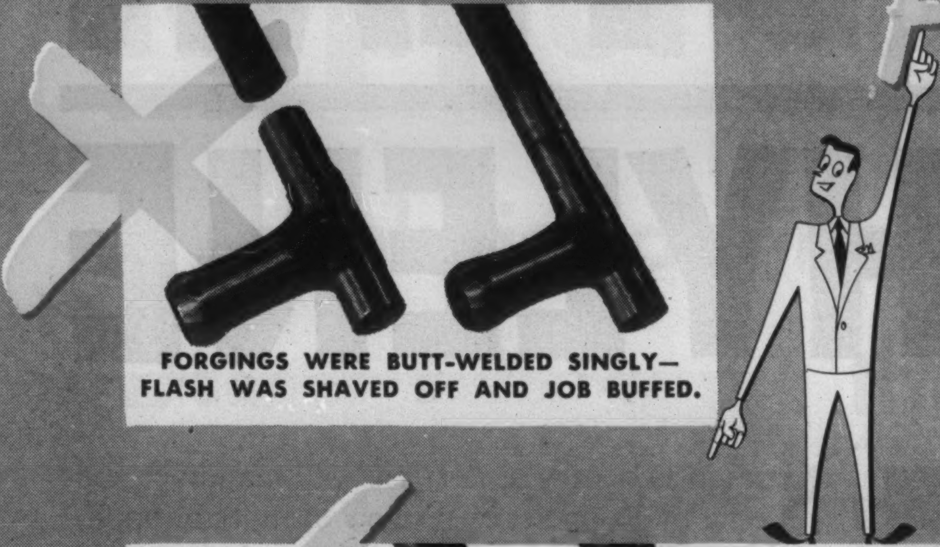
Koppers Plastics



FORD MOTOR

increases strength of this assembly and...

SAVES UP TO 20%



FORGINGS WERE BUTT-WELDED SINGLY—FLASH WAS SHAVED OFF AND JOB BUFFED.

FOUR ASSEMBLIES ARE NOW BRAZED SIMULTANEOUSLY—NO GRINDING AND BUFFING NECESSARY AFTER BRAZING.

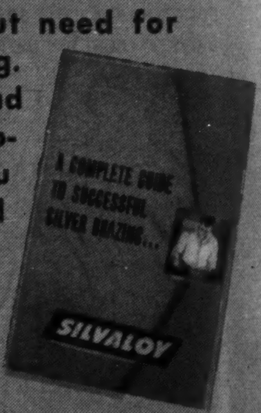
SILVALOY

LOW TEMPERATURE SILVER BRAZING ALLOY

PREFORMED RINGS ARE USED FOR THE JOB!

SEND FOR FREE GUIDE TO SUCCESSFUL SILVER BRAZING

The successful combination of Ford Engineering and Silvaloy Brazing Alloy multiplies production efficiency for this Ford Transmission Gearshift Tube and Socket assembly—*with important savings in costs!* Formerly, single assemblies were butt-welded, the flash removed and joint buffed. Now, four assemblies are brazed simultaneously—without need for grinding or buffing after brazing. A Silvaloy Technician will be glad to assist in planning brazing production in your plant, to help you cut costs, improve results and speed production. Call or write today. There's no cost or obligation, of course. ★ ★ ★ ★ ★ ★ ★



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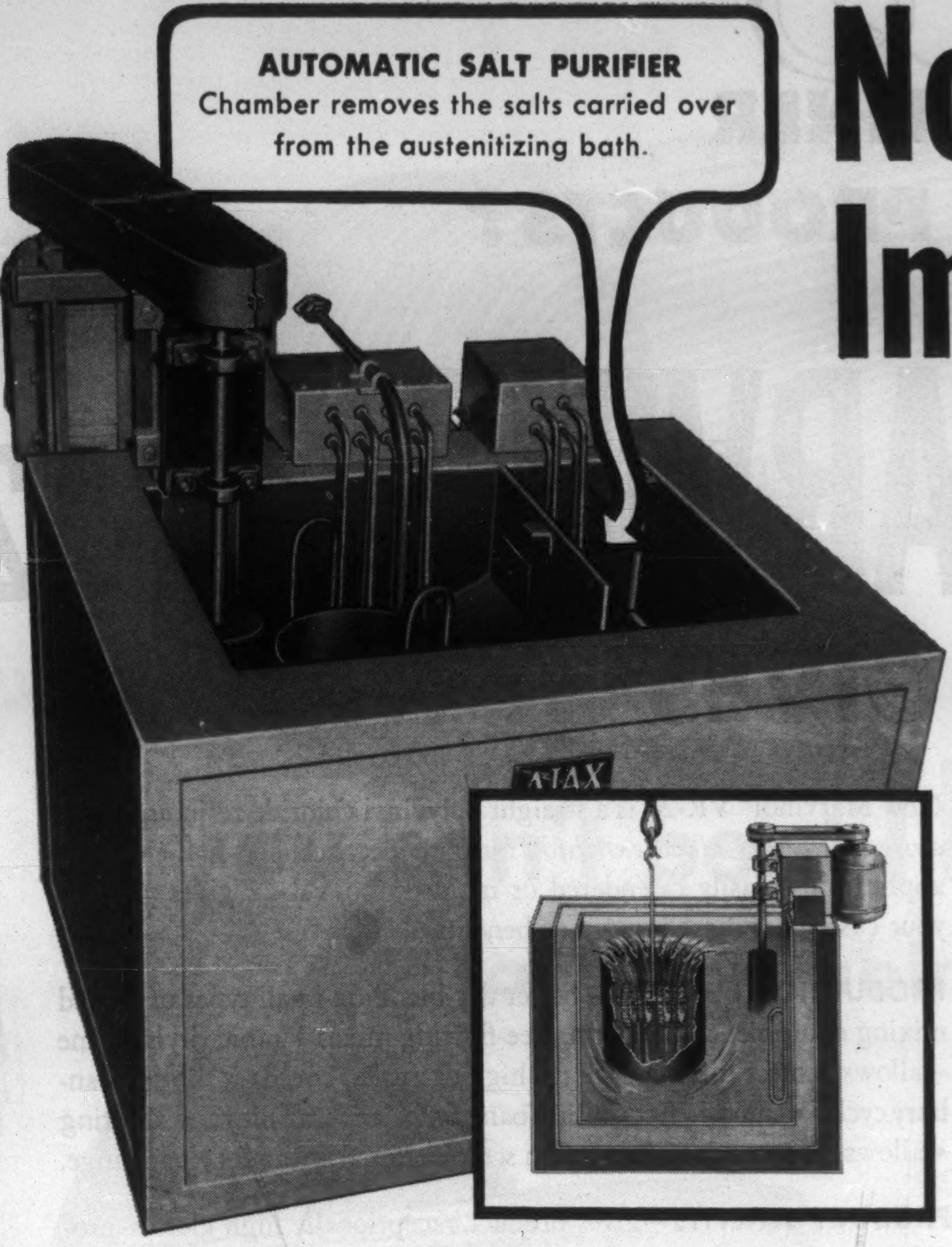
THE AMERICAN PLATINUM WORKS

231 NEW JERSEY RAILROAD AVENUE • NEWARK 5, NEW JERSEY

Now! Vastly Improved Quenching with Salt!


AUTOMATIC SALT PURIFIER
Chamber removes the salts carried over from the austenitizing bath.
AJAX

AJAX CATARACT QUENCH FURNACE

Provides greater quenching power than previously possible.

Permits heavy sections to be martempered and austempered. (Sections up to 6″ diameter, can be martempered and sections up to 1¼″ diameter austempered).

Assures high and uniform hardness.

Eliminates excessive distortion — As a rule, parts can be finish-machined *before* hardening.

Avoids danger of quench cracking.

Increases toughness and ductility.

ANY steel that can be hardened by oil quenching can now be martempered or austempered in the new Ajax Cataract Quench Salt Bath Furnace . . .

. . . with equal hardness and with all of the PLUS heat treating advantages that only molten salt can give.

This new Ajax Electric Salt Bath Furnace with its vastly increased cooling rate permits rapid quenching of steel parts through their critical temperature range.

Tremendous quenching power is obtained by an adjustable-speed pump. The downward flow of salt into the quenching header can be regulated for various hardenabilities.

Send specimen work to the Ajax Metallurgical Service Laboratory for a process demonstration—preferably in your presence . . . No obligation.

Write for Bulletin 700

"Ajax Cataract Quench Furnaces," and Technical Bulletin 500, "The Present Status of Austempering and Martempering."

Associated Companies: Ajax Electric Furnace Corp.; Ajax Electrothermic Corp.; Ajax Engineering Corp.

AJAX® HULTGREN electric SALT BATH furnaces

AJAX ELECTRIC COMPANY, 906 Frankford Ave., Philadelphia 23, Pa.

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FASTER PRODUCTION? FINER PRODUCTS?

MARVINOL VR-22

GIVES BOTH!

New Marvinol® VR-22 is a straight polyvinyl chloride resin *especially designed for dry blend extrusion* for both electrical and non-electrical applications. Easily calendered or molded, too, VR-22 gives you and your customers these important benefits.

PRODUCTION BENEFITS—better dry blending in all types of heated mixing equipment • uniform, free-flowing mixes • rapid drying time—allows shorter mixing cycles • high extrusion speeds • shorter Banbury cycles • smooth, free-rolling bank for calendered film and sheeting • allows reprocessing of your film scrap material without color change.

PRODUCT BENEFITS—gives product exceptionally high gloss • provides excellent electrical properties • produces gel-free film and sheeting • offers excellent heat, light, and color stability.

Marvinol VR-22 has already been used to advantage in... tough, glossy garden hose... efficient, attractive wire insulation... smooth, tough pipe and tubing... strong shoe welting and upholstery binding... heavy gauge press polished sheet.

Why not profit with Marvinol VR-22 for...

- window channels and panel trim?
- tough upholstery?
- primary insulation and cable jackets?
- window shades?
- electrical tape?

Why not investigate new Marvinol VR-22? And think of it in terms of the *easier production* and *extra sell* it can give *your* products. Find out more about this important new vinyl resin by writing on your letterhead to the address below.

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

Naugatuck Chemical is an original sponsor of the new Vinyl Film Standard of Quality Program.

BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • Memphis • New York • Philadelphia
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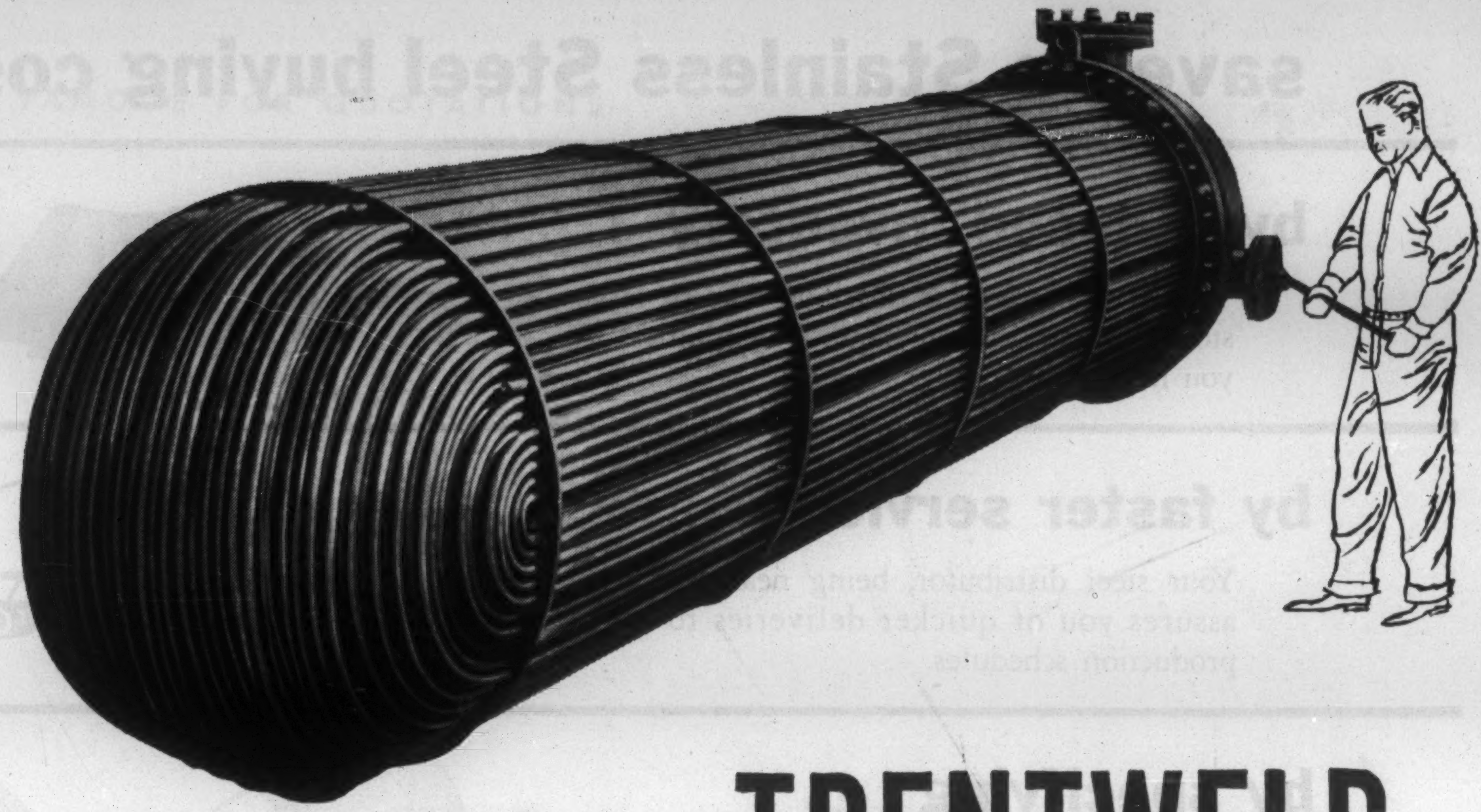
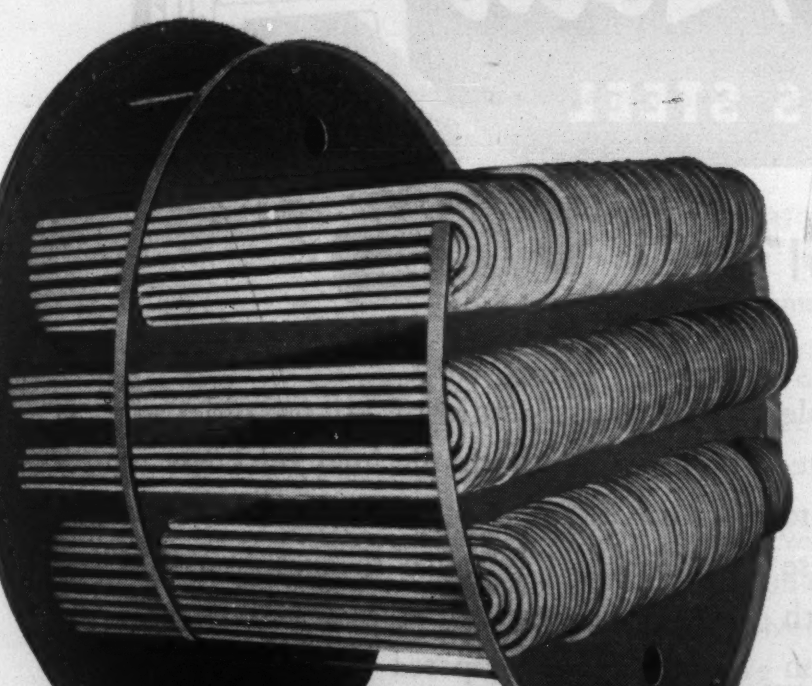


you can't beat TRENTWELD for *your* tubing requirements



Heat Exchangers built by Vulcan Manufacturing Division, Vulcan Copper & Supply Co., Cincinnati, Ohio.

Whether it's heat exchangers or milking machines, chemical equipment or fountain pens, or any of a thousand other applications, you just can't buy better tubing than TRENTWELD stainless and high alloy tubing.

One reason is that TRENTWELD stainless *welded* tubing is a product of tube mill specialists . . . worlds apart from job shop fabrication. All of our facilities are devoted solely to the production of top quality tubing.

TRENTWELD is made by an exclusive fusion-welding process in which no filler rod is used. Each piece has an accurate uniformly sound weld that is indistinguishable from the parent metal and just as strong and corrosion-resistant.

TRENTWELD is available in an extremely wide range of sizes from ⅛″ to 40″ O.D. and up, in most grades, gauges and finishes. Trent engineers are experienced in solving tubing problems in many fields. Write now and let us help with *your* application problem.

TRENTWELD

STAINLESS STEEL TUBING

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of CRUCIBLE STEEL COMPANY OF AMERICA)

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save on Stainless Steel buying costs

by reduced inventory

Your steel warehouse distributor keeps large stocks of stainless on hand. Buy stainless as you need it. ...

by faster service

Your steel distributor, being nearer to you, assures you of quicker deliveries to meet production schedules. ...

by specifying

MicroRold®

STAINLESS STEEL

with "Thinness Control"

MicroRold Stainless Steel Sheet is available through steel warehouse distributors strategically located at points most accessible to fabricators of stainless steel products. These distributors, being closely associated with the industry, not only facilitate the selection and delivery of stainless sheets but can also provide technical assistance on your stainless steel fabricating problems.

Your steel distributor will explain the advantages of buying MicroRold with "Thinness Control." This "Thinness Control" in the manufacture of MicroRold stainless sheets means the decimal thickness is uniform throughout the length and width. MicroRold is rolled to exceptionally close tolerances, as low as 3% average (plus or minus) as compared to the A.I.S.I. allowable of plus or minus 10%. Each .001″ in thickness saved results in a savings of 1.26 pounds when figured on a standard 36″x 120″ sheet. MicroRold's controlled accuracy of gauge gives you more stainless area per ton or the equivalent area with lesser weight.

Consult your nearest MicroRold Stainless Steel Distributor.
He will gladly tell you the MicroRold story.

WASHINGTON STEEL *Corporation*
Washington, Pennsylvania

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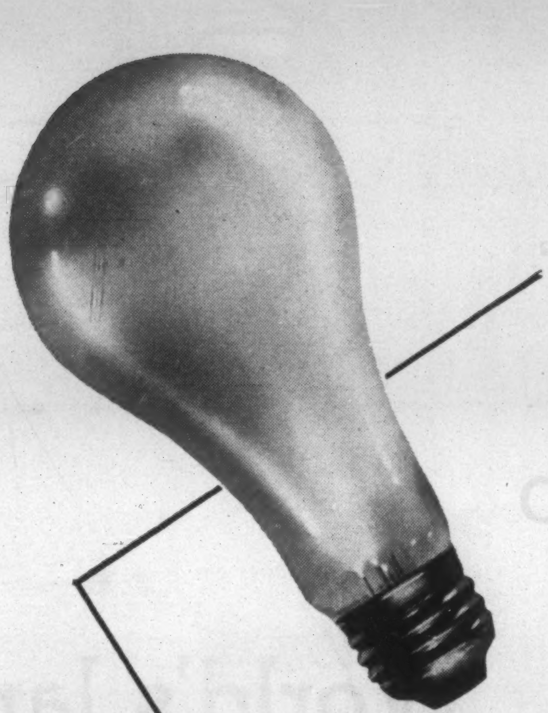

FAMOUS FOR QUOTATIONS

"IDEAS ARE THE ROOTS OF CREATION"

ERNEST DIMNET

It takes ideas—good solid ideas—to improve a product. Here are two shining examples of Wolverine product improvements in action:

The first—Wolverine extruded aluminum shapes—lets you design to tighter tolerances, enhance product appearance with satin smooth finishes.

The second—Wolverine aluminum extruded or drawn tube—gives you a chance to pare weight, adds years to product life.

Both products, along with Wolverine copper and electric-welded steel tubing, are rigidly quality controlled. *Bonus idea!* Wolverine, too, is famous for quotations. Get one before you place your next order. Aluminum alloys: 1100 (2S), 3003 (3S) and 6063 (63S). Write for the Aluminum Tube Catalog.

WOLVERINE TUBE, 1439 Central Avenue, Detroit 9, Michigan.

WOLVERINE TUBE
DIVISION OF CALUMET & HECLA, INC.
Manufacturers of Quality-Controlled Tubing
and Extruded Aluminum Shapes

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

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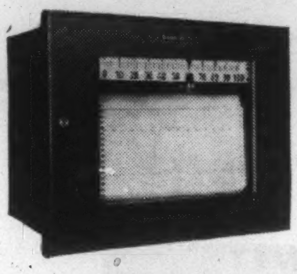
For more information, turn to Reader Service Card, Circle No. 402

Whatever your furnace needs for control—

There's good reason why more heat-treating furnaces everywhere are controlled by Brown instruments. First, of course, is performance . . . sensitive, precise control that meets the most exacting requirements of modern heat-treating techniques. And equally important is versatility. In this varied line of instrumentation you'll find just about everything a furnace could possibly need in the way of control.

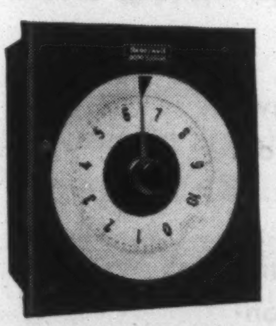
Choose *ElectroniK* Strip Chart Controllers for detailed, long-term records . . . and a selection of control forms including electric systems of the contact, position-proportioning (*Electr-O-Line*) and time-proportioning (*Electr-O-Pulse*) types; and pneumatic control from two-position to full proportional-plus-reset-plus-rate action.



Choose *ElectroniK* Circular Chart Controllers for ease of scale reading . . . convenient daily charts; in a full range of electric and pneumatic control forms.

Note: the basic components of all *ElectroniK* models are interchangeable . . . to simplify and speed up service.

Choose *ElectroniK* Circular Scale Controllers where you want readability and control check at extreme distance . . . without need for a record. Supplied with all contact and proportional types of electric control.



Note: all *ElectroniK* models are available in both Standard and Precision Series.

Choose *Pyr-O-Vane* Controllers where you don't need a record but do need precise vane type snap action electric control by a millivoltmeter instrument... also available with pulse-type time proportioning action, in both vertical and horizontal models.

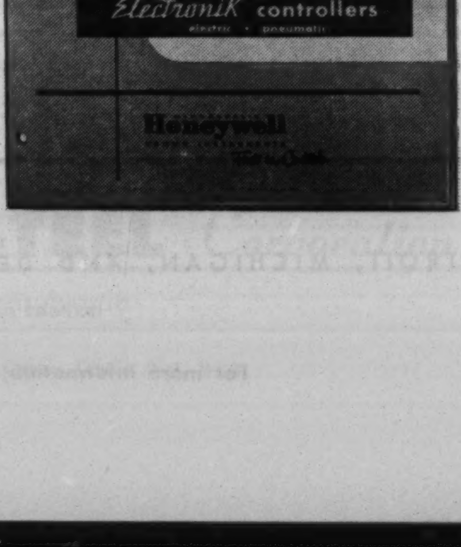
Choose the *Protect-O-Vane* Safety Cut-Off for simple, dependable excess temperature protection ... can be used with any temperature control to prevent furnace shut downs and loss of production.

• • •

And for all your pyrometer supplies, investigate the convenience and economy advantages of the HSM Plan.

Product of the engineering skill of C. I. Hayes, Inc., of Cranston, R. I., this giant furnace has a heating chamber 19' long, 8' 2" high and 4' wide.

World's largest electric steel forging furnace



Listed in Catalo
1531 are the vari
types of Electroni
Controllers . . . i
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affording a bro
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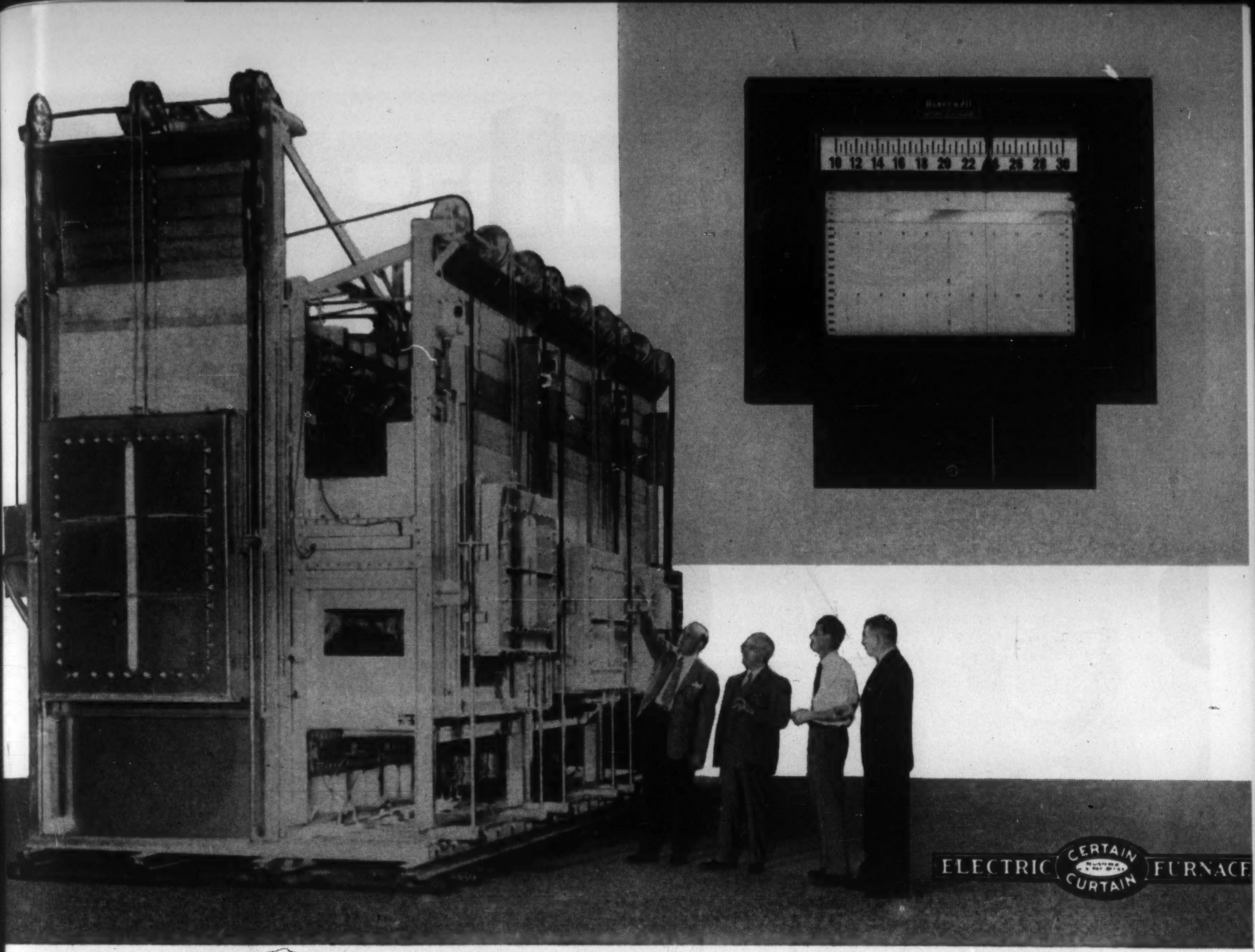


uses *ElectroniK* instruments

SPECIALLY DESIGNED and constructed by C. I. Hayes, Inc., this mammoth furnace will heat up to 10,000 lb. billets for forging in a 50,000-ton press at Wyman-Gordon Co.

Forty-five Globar elements, with a total connected load of 600 kilowatts, supply the heat input for an operating temperature of 2400°F. under a controlled atmosphere.

Accurate, dependable instrumentation is required . . . to keep the heating cycle as short as possible, for power economy . . . to avoid temperature override, for protection of furnace and work. Sixteen *ElectroniK* proportional controllers were selected to handle this responsibility, and will help Wyman-Gordon Co. set production records with the largest "Certain Curtain" furnace ever built.

Through continuing cooperation with furnace manufacturers and users, Honeywell is applying the *ElectroniK* principle to countless control problems. The improvements in operating efficiency, product quality, production rate, and savings in materials and labor have earned an enviable reputation for *ElectroniK* controllers.

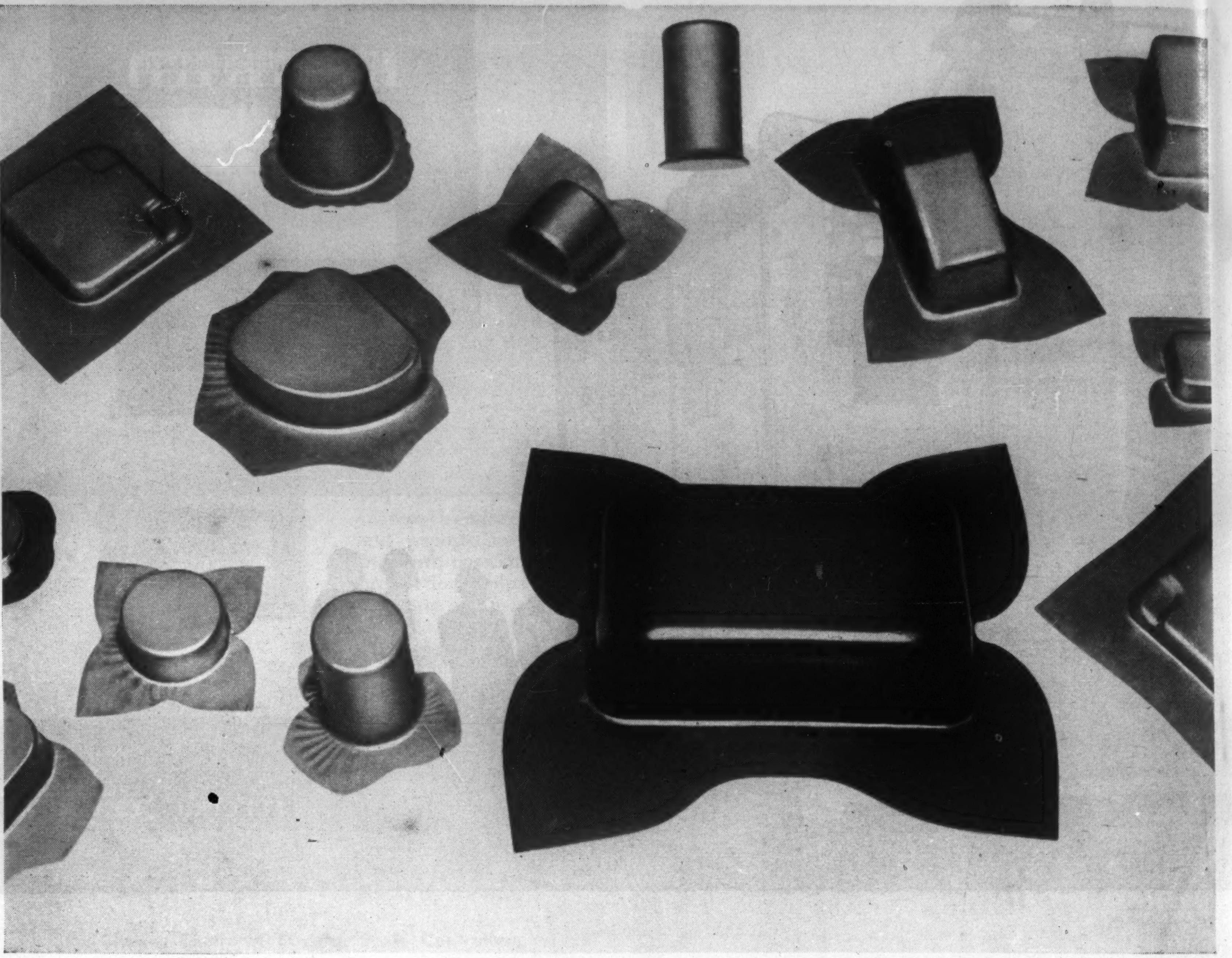
These instruments, and others in the complete Honeywell line, are highlighted on the opposite page. To help select the type that suits your specific needs, call in your local Honeywell sales engineer for a detailed discussion . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

H
HONEYWELL

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

For more information, turn to Reader Service Card, Circle No. 470



Deep-drawn parts made from REM-CRU titanium by Brooks and Perkins, Inc., Detroit, Michigan

now, make it TITANIUM even for deep-drawn parts

Titanium is a *practical* design material . . . even for deep-drawn parts. Techniques similar to those used for magnesium permit the forming of intricate sections without difficulty.

Deep-drawn and other fabricated parts of titanium have properties that make them truly remarkable. For instance, they're strong as stainless steel, but 44% lighter. They're exceptionally resistant to most forms of corrosion . . . entirely impervious, for example, to sea water or marine atmospheres. The modulus of elasticity is higher than for the other light metals . . . thermal conductivity and coefficient of expansion low.

So, for a tough, strong, light metal with many exceptional characteristics, consider REM-CRU titanium. And note that you'll get prompt delivery of the sizes and grades you order, because REM-CRU's substantially increased facilities mean that all standard mill forms and finishes are readily available. Let a REM-CRU engineer help you select the grade of titanium that will serve you best.

To keep abreast of the latest developments on this vital metal, write to Dept. M6 for the Rem-Cru Review—a free periodical presenting the latest technical data on titanium alloys.

**REM-CRU
TITANIUM**

REM-CRU TITANIUM, INC., MIDLAND, PENNSYLVANIA

For more information, turn to Reader Service Card, Circle No. 307

EPON® RESIN does it!

a tougher, more corrosion-resistant primer for metal lawn furniture . . . *at lower cost*

New Epon primer, formulated by The Glidden Company, Cleveland, is the key to a better finish on metal lawn furniture.

HERE'S HOW...

EXPOSED to blistering sunlight, rain, and often to corrosive salt sea breezes—lawn furniture must have a tough, corrosion-resistant finish.

For this reason, the Troy Sunshade Company has set high standards of durability and appearance for finishes on its quality metal lawn furniture. When metal shortages made it necessary to abandon chrome plating, Troy engineers made a careful study of paints and paint-finishing methods. Tests showed that the *primer* coat was the key to paint durability . . . *and that an Epon resin-based primer gave improved appearance and the highest degree of resistance to corrosion.*

The Epon resin-based primer is applied by rotary spray coating. The finish coat is applied by electrostatic spraying. Both operations are completely conveyorized. Thanks to the excellent adhesion and leveling properties of the Epon primer, expensive sanding operations are reduced to a minimum. Troy engineers estimate that the new finishing system saves as much as a dollar a gallon on materials, in addition to savings in labor costs.

• • •

Call on our sales offices for names of suppliers who sell Epon resin coatings. Write for the full Epon coatings story in the new brochure, "Planning to Paint a Pyramid?"

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DoALL COMPANY ENGINEERS GET...

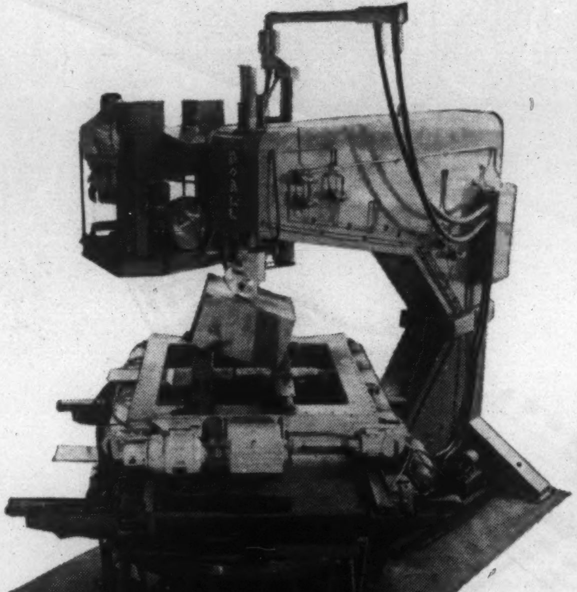
HIGH STRENGTH

with NO HEAT TREAT DISTORTION

by specifying

STRESSPROOF®

SEVERELY COLD-WORKED, FURNACE-TREATED
STEEL BARS



The new giant DoALL Contourmatic band saw — the world's largest — is a key part of the Air Force's "Heavy Press Program." STRESSPROOF is used on important operating parts.

on key operating parts

The lead and feed screws on the new DoALL Contourmatic must be strong since they transmit power. These important lead and feed screws must also be straight and free from growth and shrinkage, since upon their accuracy depends the accuracy of the huge extrusion dies machined on the saw. STRESSPROOF gives them this strength and accuracy.

STRESSPROOF was specified because it eliminates heat treating and its attendant distortion and warpage problems. In addition, STRESSPROOF wears well, has the necessary strength and is easily machined.

STRESSPROOF makes a better part at lower cost.

IMPROVE QUALITY
CUT COSTS
STRESSPROOF
La Salle

Write for helpful data bulletin No. 15 . . . "Improve Quality — Cut Costs"

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COAST-TO-COAST**

La Salle **STEEL CO.**

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QUALITY COLD-FINISHED STEEL BARS**

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for man-sized
problems
and larger...

Bigelow

has the
solution!

BIGELOW
Fiber Glass
Products

20,000-gallon tank for waste chemicals fabricated by the Carl N. Beetle Plastics Corp., Fall River, Mass.

BIGELOW FIBER GLASS PRODUCTS CAN SOLVE YOUR PROBLEMS NO MATTER HOW COMPLEX

Problem solution through superior reinforcing materials is indeed Bigelow's most important product! This engineering service plus a complete line of glass reinforcing materials—glass mats, woven roving, and glass cloth puts Bigelow Fiber Glass Products way out in front! For further information, fill out this coupon:

Bigelow had a tall order—furnishing a *reinforcement* strong and uniform enough to be used in fabricating a large tank—*and at the lowest possible cost!* The Carl N. Beetle Plastics Corp. selected Bigelow for their record of accomplishment in the fiber glass field.

A unique fiber glass product was engineered—ROVCLOTH 6060-0505 (Bigelow's trademarked woven roving) . . . 25.5 oz. weight, breaking strength in excess of 900 lbs. in warp and fill, with an .050" thickness, and 108" in width. This resulted in an end product that met all specifications for corrosion-resistance!

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Division of
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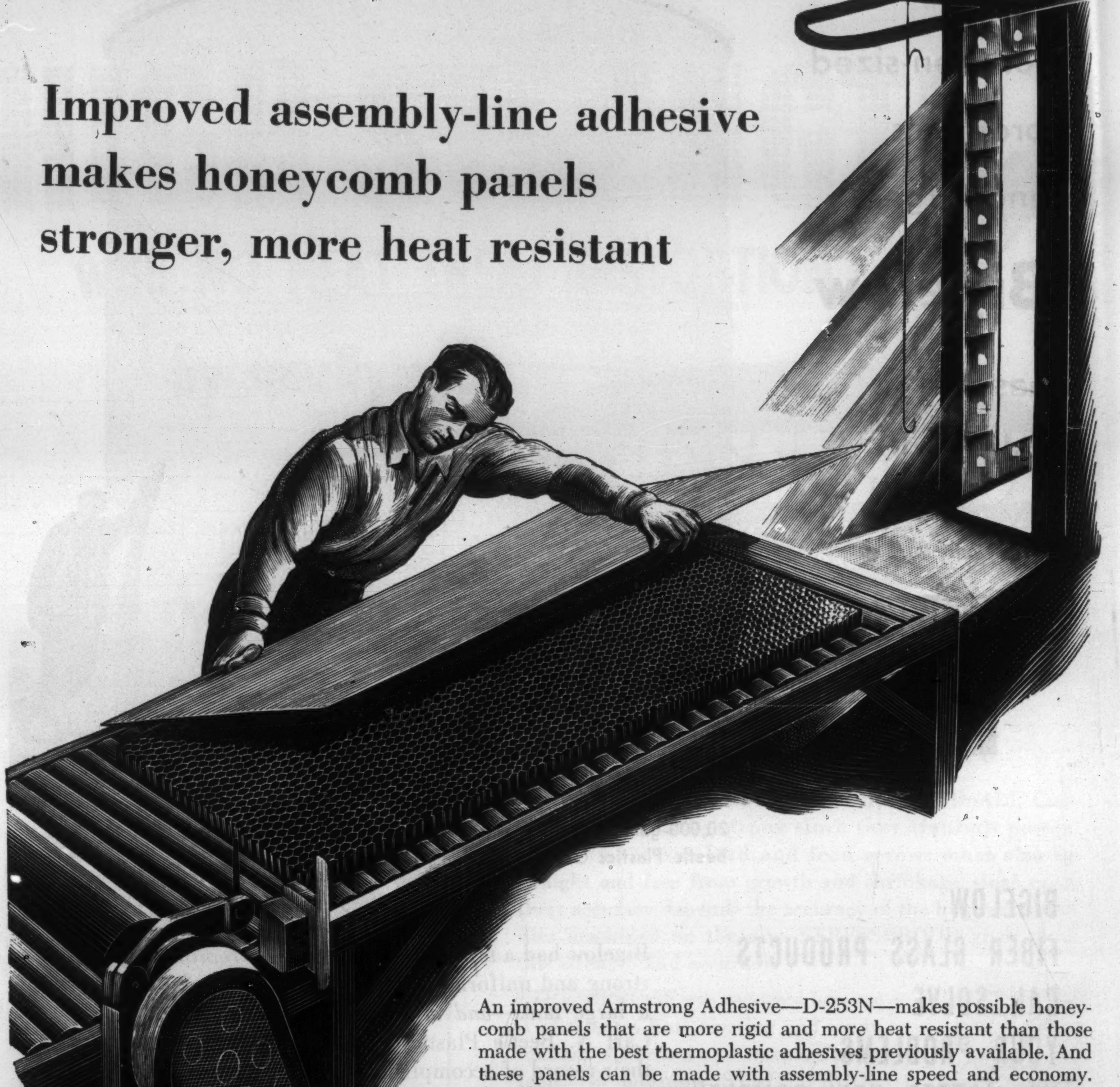
FIRM ....
ADDRESS ....
CITY .... STATE ....

For more information, turn to Reader Service Card, Circle No. 390

Improved assembly-line adhesive makes honeycomb panels stronger, more heat resistant



An improved Armstrong Adhesive—D-253N—makes possible honeycomb panels that are more rigid and more heat resistant than those made with the best thermoplastic adhesives previously available. And these panels can be made with assembly-line speed and economy.

Panels made with D-253N are stronger because this adhesive can hold a dead load twice that of the best conventional thermoplastic cements. And D-253N's greater heat resistance makes it useful at temperatures up to 180°F. These characteristics virtually make D-253N a new type of adhesive, one that's intermediate between thermoplastic and thermosetting cements.

Armstrong D-253N simplifies assembly-line bonding of panels. Applied by spray gun or roller coater, it dries under infrared heat in less than a minute. And it requires only momentary pressure to form a high strength, permanent bond.

For more information on D-253N, or a copy of the catalog describing other Armstrong Adhesives, write Armstrong Cork Company, Industrial Division, 8006 Dunbar Street, Lancaster, Pennsylvania. In Canada, please write to 6911 Decarie Boulevard, Montreal.

Armstrong

ADHESIVES • COATINGS • SEALERS

... used wherever performance counts

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Bridgeport HIGH I.Q.
Silicon Aluminum Bronze Rod

It machines 50% to 70% as fast as free-cutting brass . . . is 9% lighter, 50% stronger than half-hard Naval brass, has excellent corrosion resistance and a tensile strength of 85,000 psi when annealed.

You can profit by using Bridgeport Silicon Aluminum Bronze Rod for high-strength screw machine parts, marine and pole line hardware, valve stems and pump parts, nuts and bolts. Free machining means faster production, longer tool life. High strength means superior wear, top performance.

We'd like to put these advantages to work for you. Our representative will be glad to show you how the *High Inner Quality* of Bridgeport Silicon Aluminum Bronze and other Bridgeport Alloys can help you to product improvement.

NINETY YEARS Bridgeport PROGRESS IN METALS

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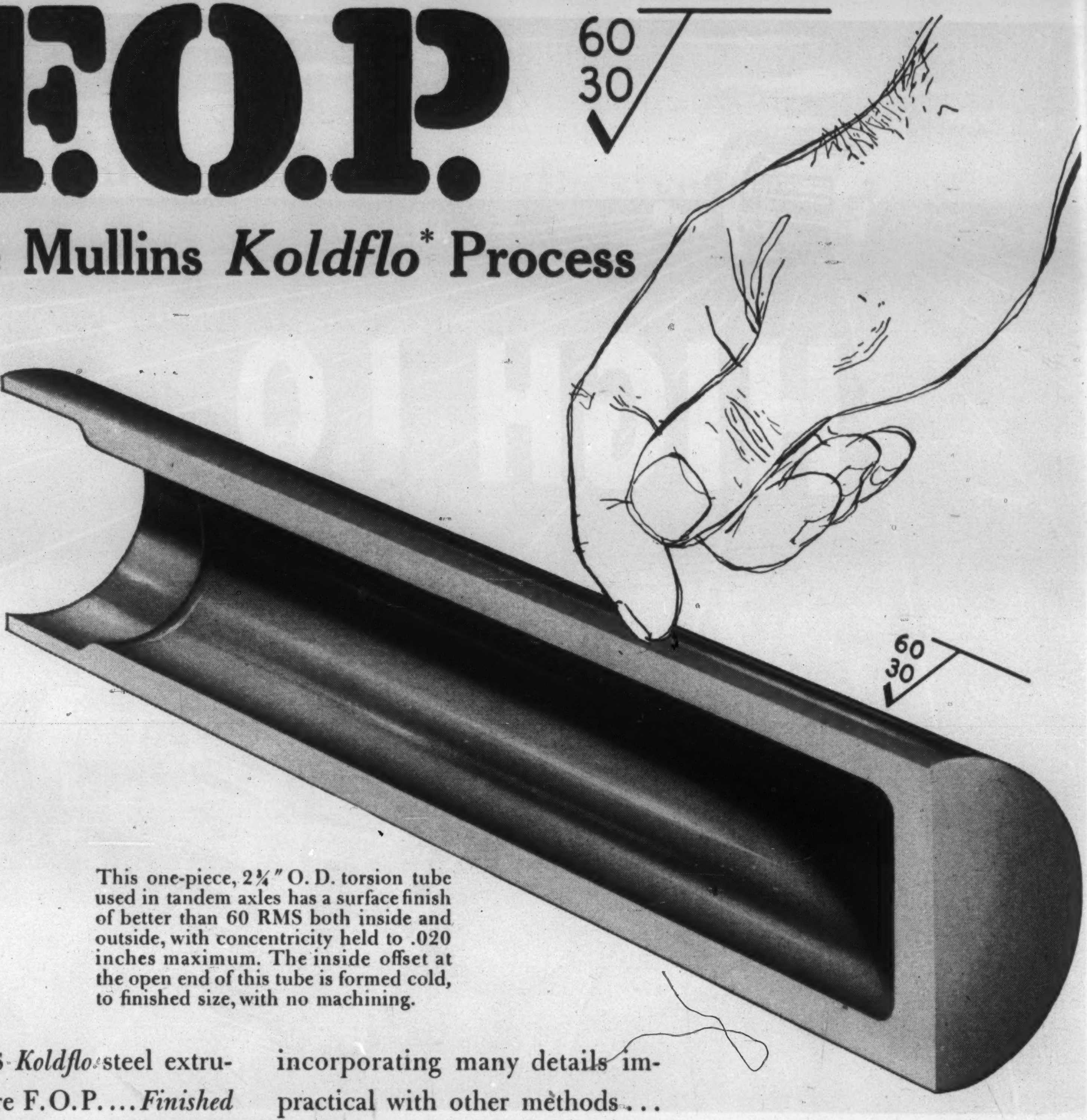
F.O.P.

by the Mullins *Koldflo** Process



This one-piece, 2¾" O. D. torsion tube used in tandem axles has a surface finish of better than 60 RMS both inside and outside, with concentricity held to .020 inches maximum. The inside offset at the open end of this tube is formed cold, to finished size, with no machining.

MULLINS *Koldflo* steel extrusions are F.O.P. . . . *Finished On Presses* to a surface finish of 60 RMS or better. In case after case, these cold extrusions meet specified tolerances and surface requirements as produced, eliminating the finish machining or grinding required on parts produced by conventional methods.

Too, you can forget many of the design limitations of conventional methods when you design for *Koldflo*. We can produce precision cylinders with integral ends, incorporating many details impractical with other methods . . . all in a one-piece design. Mullins *Koldflo* steel extrusions can be furnished in a variety of shapes and sizes and with a choice of mechanical properties.

If you require precision cylindrical steel parts in high volume, give us your specifications, and quantity required . . . We'll be glad to show you how *Koldflo* can turn your new designs into new and better products.

How would you tool-up to make an egg?

"How Would You Tool-Up To Make An Egg?"
For copy of new and expanded booklet, write Koldflo Division, Dept C-6, Mullins Manufacturing Corporation, Warren, Ohio.

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choose CRUCIBLE COLD ROLLED STEELS

for finer finish...better edges...closer tolerances

Crucible's *complete* quality-control during production of cold rolled alloy specialty strip steels means *extra* performance in your shop. And Crucible-patented production equipment makes possible cold rolled steels with finer finish, better edges, greater physical uniformity, and closer tolerances.

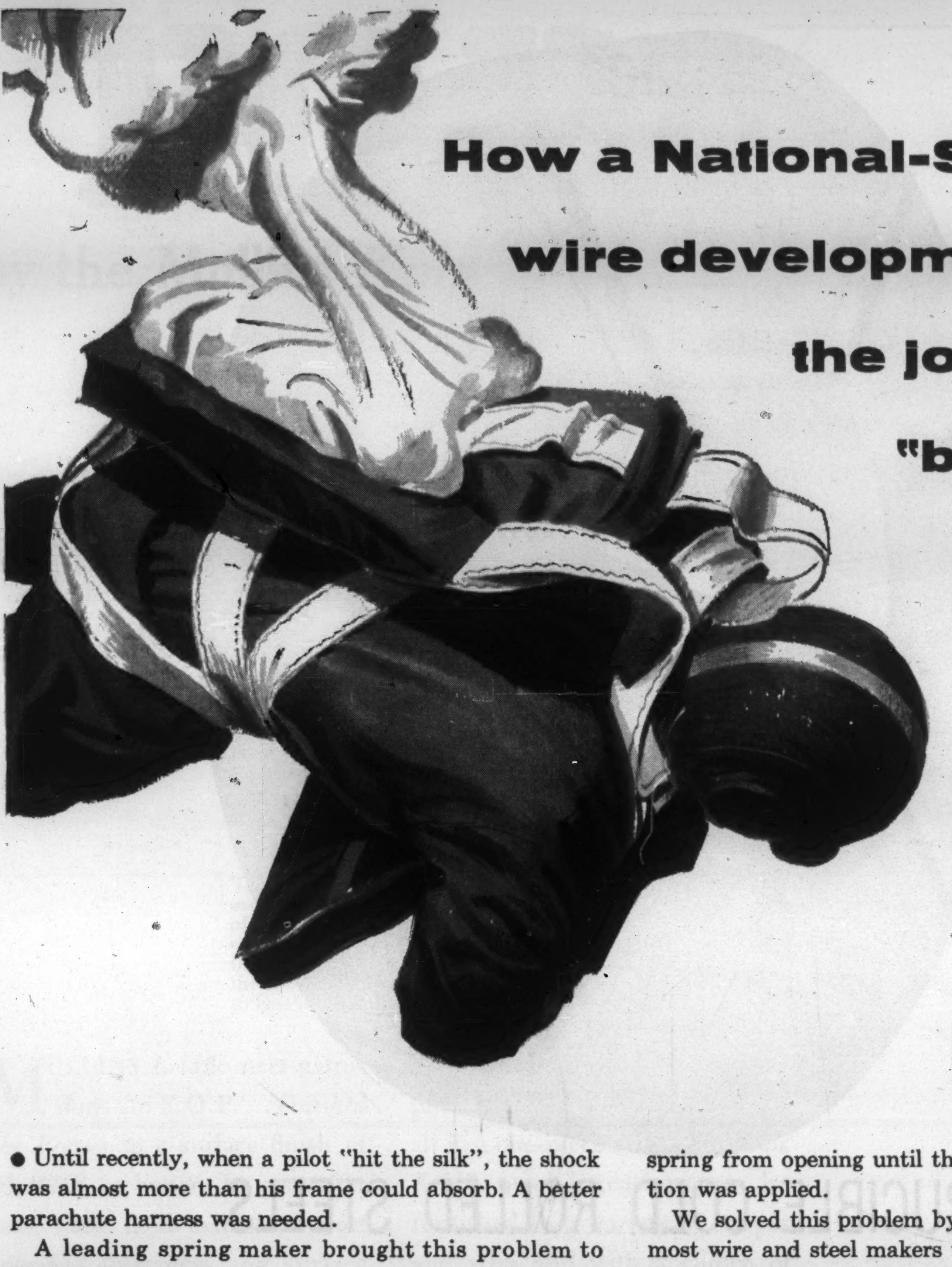
At Crucible, the country's leading producer of *special purpose steels,* you'll find a group of metallurgists experienced in cold rolled steels who are ready to help you develop your specification. You'll get the steels you choose fast, too, for Crucible cold rolled stocks are large... both in coils and cut lengths.

So come to Crucible for *all* your cold rolled steel needs. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 30, Pennsylvania.*

CRUCIBLE **first name in special purpose steels**

Crucible Steel Company of America

For more information, turn to Reader Service Card, Circle No. 381



How a National-Standard wire development took the jolts out of "bail-outs"

● Until recently, when a pilot "hit the silk", the shock was almost more than his frame could absorb. A better parachute harness was needed.

A leading spring maker brought this problem to National-Standard.

Our engineers came up with a special stainless steel wire that would take the severe forming stresses created in coiling long, thin springs. In addition, this wire could be made into springs with unusual resistance to permanent set. And, finally, this wire enabled the spring designer to create a spring with high initial tension . . . a sort of delayed action characteristic which prevented the spring from opening until the severe shock of deceleration was applied.

We solved this problem by staying with it long after most wire and steel makers would have given up. It is this stay-with-it approach that has enabled National-Standard to solve more of the fussy problems in steel and wire making than anyone else in the industry.

If you have a need for steel or wire with unusual or even "impossible" characteristics, check first with National-Standard. We may already be making such products. And, if we don't know how to make it now, we'll learn.

NS
NATIONAL-STANDARD
Company
NILES, MICHIGAN

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Tire Wire, Stainless, Fabricated Braids and Tape
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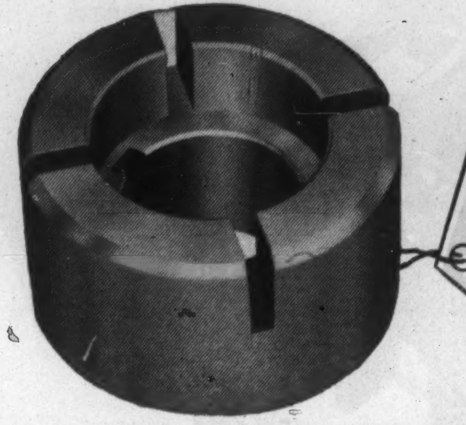
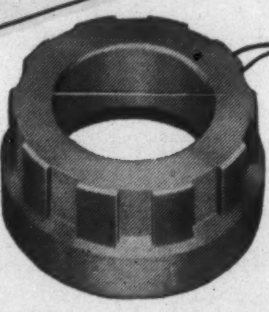
Special Machinery for Metal Decorating
WORCESTER WIRE WORKS DIVISION • WORCESTER, MASS.
Round and Shaped Steel Wire, Small Sizes

For more information, turn to Reader Service Card, Circle No. 319

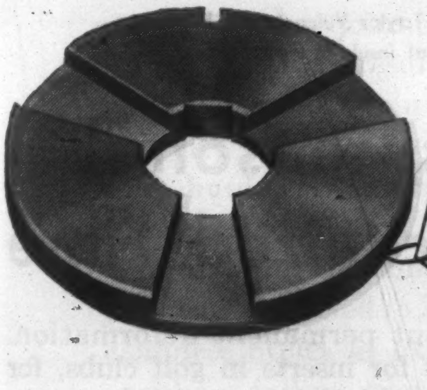
keyways splines and slots in these GRAMIX® parts are practically FREE!



IRON COUPLING
4 SLOTS,
1 KEYWAY
20c
0c
20c

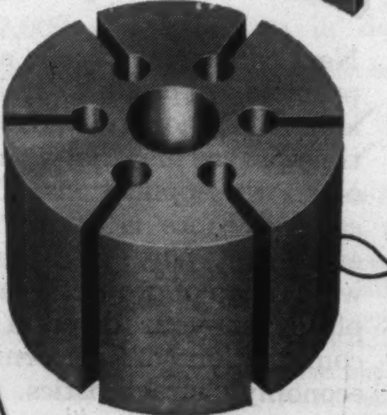


IRON ADJUSTER KNOB
10 SPLINES
6c
0c
6c

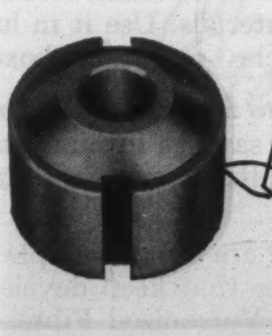


BRONZE ACCELERATOR PLATE
3 GROOVES,
1 KEYWAY
3 SPLINES
16c
0c
16c

BRONZE ROLLER CAGE
8 ROLLER SLOTS
6c
0c
6c



IRON FUEL PUMP ROTOR
6 SLOTS
17c
0c
17c



BRONZE BEARING
2 KEYWAYS
4c
0c
4c

Because GRAMIX parts are pressed to shape rather than machined, all these keyways, slots and splines are in the die impression, so there is no machining cost. And the extra cost of dies is offset by the value of the metal saved. GRAMIX parts are made from metal powders compacted in presses and then sintered at high temperatures. Intricate shapes such as these can be held to tolerances as fine as .0005". They can be oil-impregnated to provide self-lubrication. GRAMIX parts cost less than machined parts yet often outlast them. Write today for full details.

OUR 101ST YEAR

111

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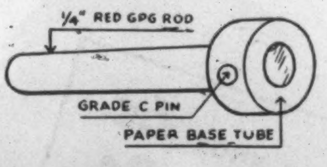
TAYLOR
Laminated Plastics
Vulcanized Fibre

Shop Talk

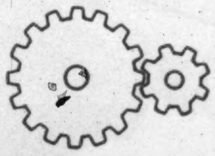
TAYLOR FIBRE CO.
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

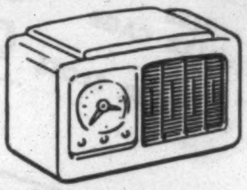
Tips for designers



Reset cam button is made of Taylor Polyester Glass Rod. Colored all the way through, it needs no painting or machining. Color never wears off.



Strong, silent gears are readily machined out of Taylor fabric base phenol laminates . . . noted for high mechanical strength.

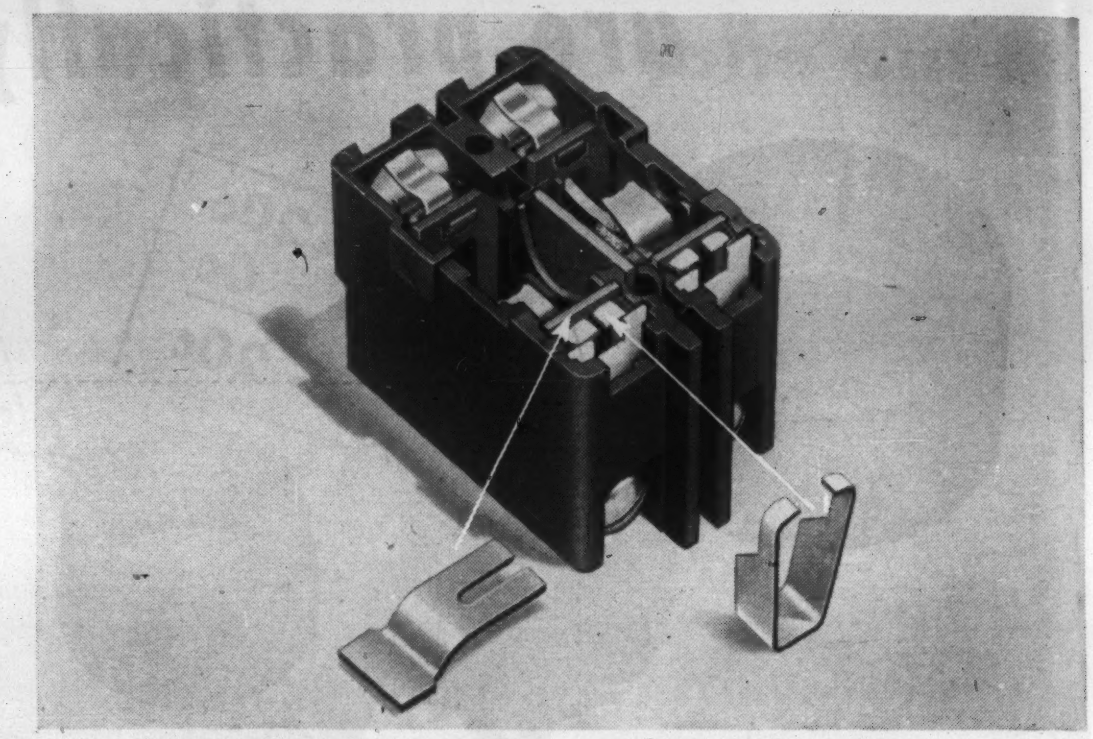


Perforated sheets of Taylor Vulcanized Fibre or Taylor Phenol Laminates make economical, high-strength speaker grilles for radio and TV sets.

Pop-up toaster switch and relay insulation was changed from laminated mica to Taylor G-5 Laminate . . . for easier fabrication and excellent heat resistance.

TAYLOR FABRICATING FACILITIES

Your production can be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts to your specifications. Efficient, modern facilities are ready to serve you. Get in touch with Taylor about your specific requirements.



Arc chutes in this circuit breaker are made of Taylor Vulcanized Fibre . . . noted for its arc resistance and electrical insulating properties.

Versatile properties, reasonable cost — try Taylor Vulcanized Fibre

Next time you tackle a materials problem in product design take a look at Taylor Vulcanized Fibre. A time-proved material with thousands of known applications, Taylor Vulcanized Fibre is finding new uses every day. Why? Because it offers a wide range of properties at low cost, places at your disposal a unique combination of performance and economy characteristics.

It's an excellent insulator . . . widely used in electric motors, transformers, appliances and scores of like products.

It's arc-resistant . . . does not readily carbonize and form arc paths, won't track due to air arcs. Use it in arc chambers and chutes in circuit breakers and switches.

It's strong . . . has excellent tensile and compressive properties, resists wear and abrasion. Use it in gaskets, washers, cams, workbench tops, sanding discs, and other structural parts.

It's resilient . . . takes severe shock without permanent deformation. Use it for inserts in golf clubs, for bumper blocks . . . anywhere you need high impact resistance.

It machines to high finish . . . produces smooth, long-wearing surfaces. Use it in textile shuttles and bobbins and other parts.

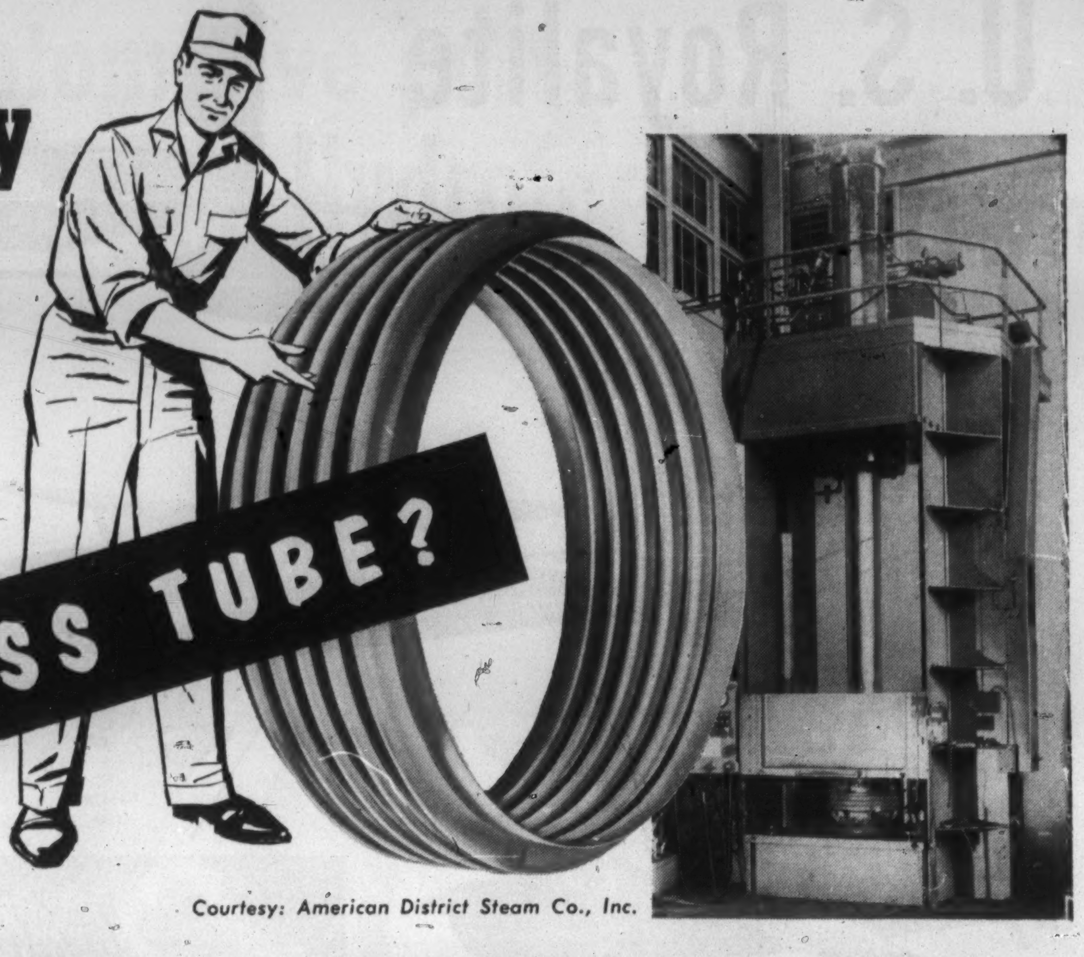
It bonds readily . . . to itself, to wood or to other materials. Use it in luggage, receptacles and mill boxes.

It's economical to fabricate . . . provides real cost savings in punching, stamping, drilling, cutting and forming.

Actually, these are only a sample of the applications that keep developing for Taylor Vulcanized Fibre. It comes in a choice of eight different grades, and in a variety of colors. It is supplied in the largest sheet size in the industry . . . also in rolls, strips and turned rods. A Taylor representative near you will be glad to discuss ways that you can put this material to work in your products.

For more information, turn to Reader Service Card, Circle No. 444

How many push-ups in a STAINLESS TUBE?



Courtesy: American District Steam Co., Inc.

The service life of this corrugated element depends on its ability to do push-ups.

Hydraulically formed from a welded stainless steel tube, it's a vital part in a Corruflex pipe expansion joint. In operation it absorbs the motion that results from pipe expansion and contraction. Often used in inaccessible locations, it's produced to rigid standards to eliminate shutdowns . . . loss of manhours . . . and maintenance costs.

In a recent durability test (see photo) the joint was subjected to 22,000 push-ups . . . 22,000 complete cycles of extension and compression —without failing. Flexing was stopped only because requirements had been met. Trouble-free tubing for this grueling application is regularly furnished by Frasse — in stainless types 304, 316 and 347—in sizes from 4¼" O.D. up to 54¾" O.D. !

Frasse specializes in furnishing *quality* tubing for exacting applications — and stocks in conveniently located warehouses a complete range of sizes in carbon, alloy and stainless analyses for you to work with. And, equally important, Frasse engineers will gladly work with you in determining the right size and grade needed to do the job. When you need tubing or tubing guidance—*always call Frasse.*

FRASSE

for everything in Steel Tubing

If you use tubing . . .

Send for this new folder describing *all* Frasse tubular products. Details include analyses, size ranges, mechanical and physical properties—also fabricating hints and ideas for end uses. Frasse tubing "specials" are included too! Mail the coupon for your copy—it's free!

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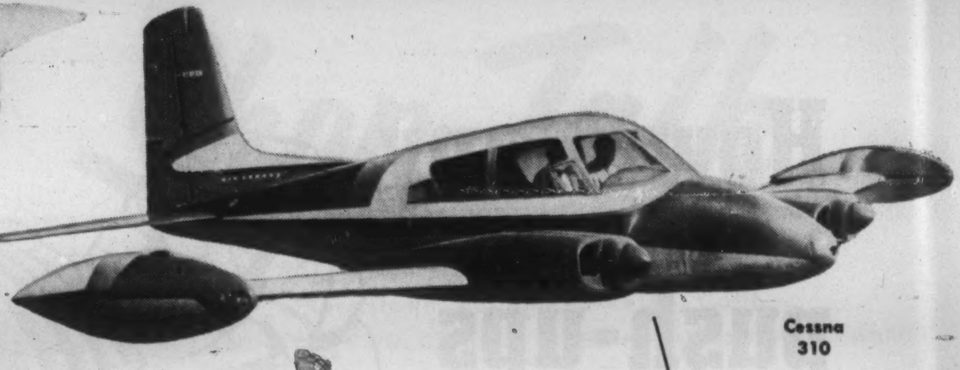
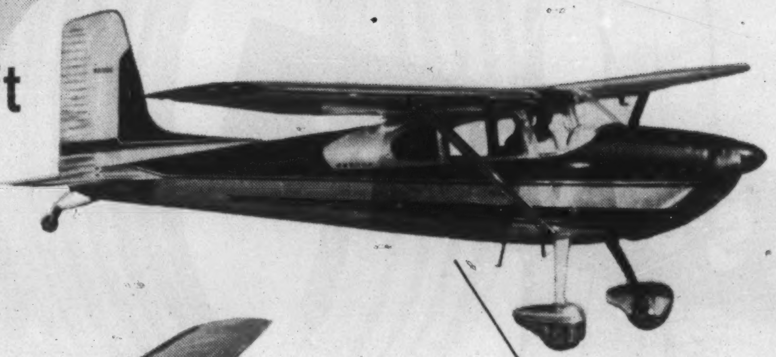
For more information, turn to Reader Service Caard, Circle No. 340

U. S. Royalite wins its wings

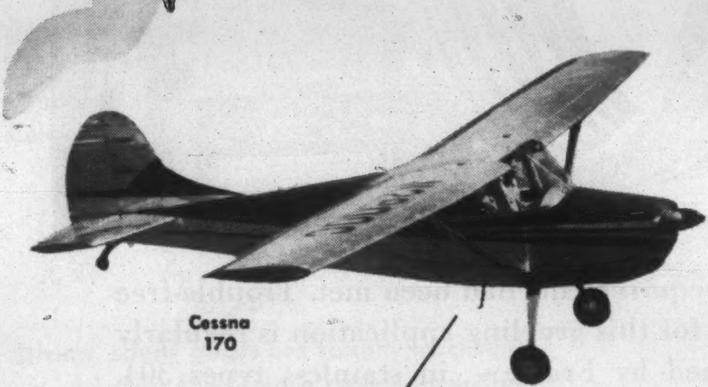
in the aircraft industry



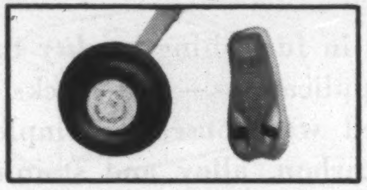
Cessna 310

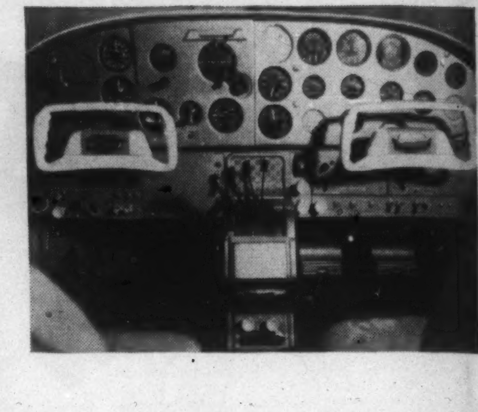


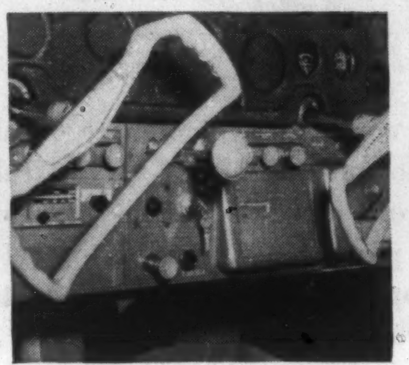
Cessna 180



Cessna 170







Tough, versatile Royalite has found increasing and diversified uses in the aircraft industry.

Cessna Aircraft Company, Wichita, Kansas, builders of fine personal and executive airplanes, was among the first to recognize Royalite's advantages.

Royalite was first used in the Cessna 170 several years ago. Later, more uses were found in the Cessna 180. The luxurious new Cessna 310 has even more Royalite parts, many in the handsome interior. There have been increasing uses with each new model. Yes, the aircraft industry, like so many other industries, is finding more and more uses for Royalite. Here are 6 of the important reasons:

- Tough, high impact strength, and long wear.
- Beauty and durability of color and grain finish.
- Lighter weight than commonly used metals.
- Low tooling costs and inexpensive forming operations.
- Resistant to most oils, acids and chemicals.
- Engineering and design versatility for contours and sharp detail.

Manufacturers in almost every field have used Royalite in solving production and cost problems. There's a Royalite use for *your* product. Get all of the facts. See how Royalite can improve appearance and performance—*and cut costs.*

U.S. ROYALITE

TOUGH, VERSATILE FABRICATING MATERIAL

US RUBBER

Write, wire, phone:

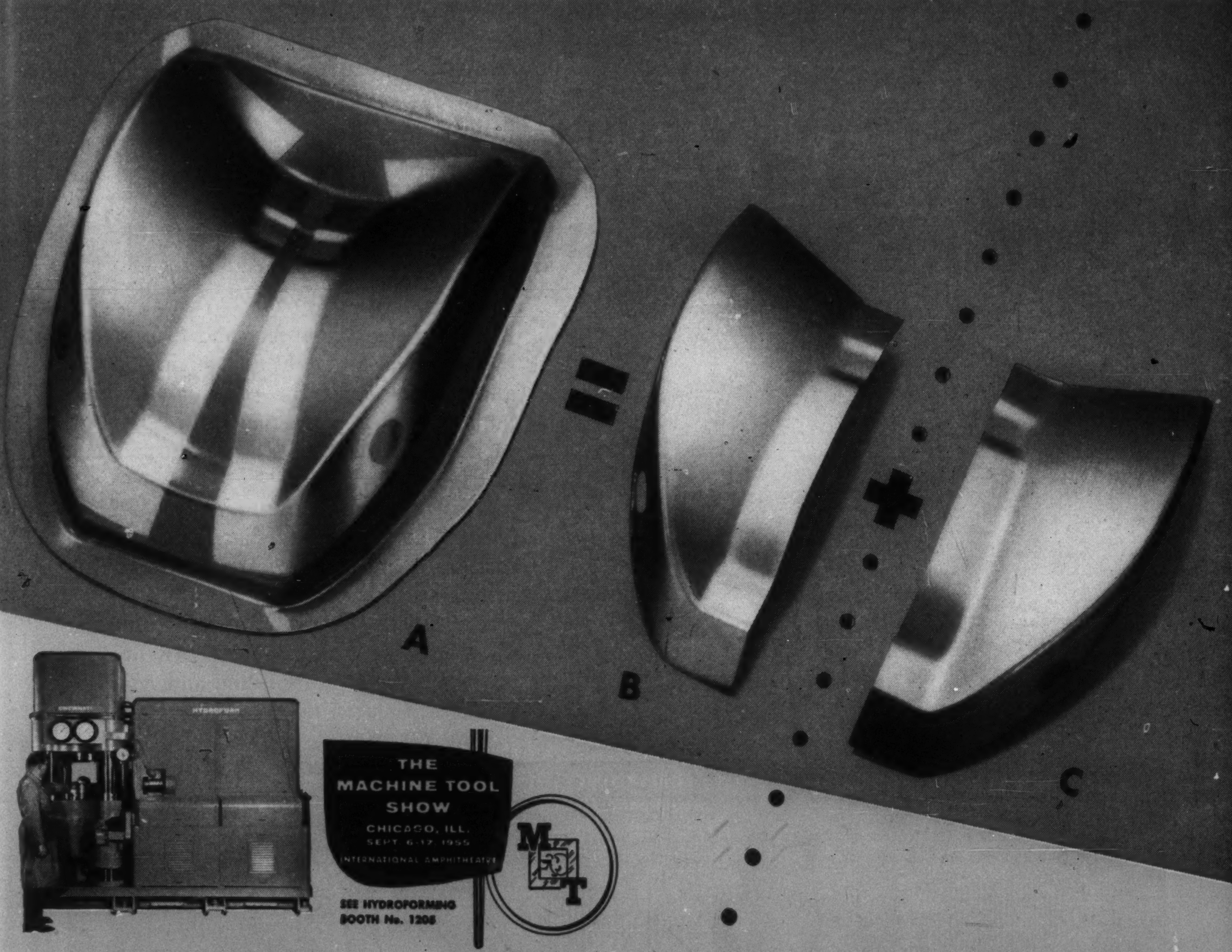
UNITED STATES RUBBER COMPANY

2638 NORTH PULASKI ROAD, CHICAGO 39, ILLINOIS

For more information, turn to Reader Service Card, Circle No. 416

For more information, Circle No. 403 ➤

Tricky automotive part gets the Hydroform treatment



THE MACHINE TOOL SHOW
CHICAGO, ILL.
SEPT. 6-17, 1955
INTERNATIONAL AMPHITHEATRE

SEE HYDROFORMING BOOTH No. 1205

With the help of the Cincinnati Hydroform, a supplier to the automobile industry has greatly simplified his production of complex-curved, right-hand and left-hand body structural components.

In the example illustrated above, shape "A" was accurately developed, then readily drawn on a 12″ Hydroform from a 10¾″ dia. blank of 20 gage cold rolled steel. (Note the extreme variations in contours.) Parts "B" and "C" were produced simply by sawing the parts out of the drawn shape. Shape "A" has been masked and paint sprayed, forming guide lines for sawing.

Tool costs were exceptionally low. The Hydroform punch was cast to shape in Kirksite. The draw ring was made from ordinary steel, with a band-sawed opening for the punch.

A similar Hydroforming procedure to that described above is being used successfully, with very substantial time and tool-cost savings, for the forming of duct sections for jet engines from heat-resisting materials.

Have you fully investigated the many Hydroforming advantages . . . and if Hydroforming can be profitably applied to your work? Let a Cincinnati Milling field engineer give you complete information. For a description of the Hydroforming process and specifications of the 8″, 12″, 19″, 23″, 26″ and 32″ machine sizes, write for Bulletin M-1759-3.

Hydroform

PROCESS MACHINERY DIVISION
THE CINCINNATI MILLING MACHINE CO.
CINCINNATI 9, OHIO, U. S. A.

CINCINNATI

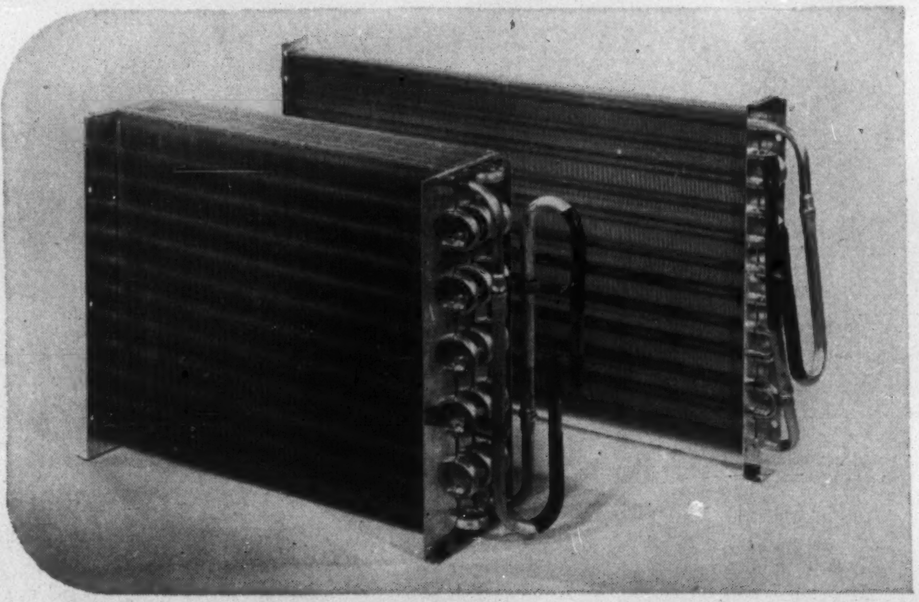
REYNOLDS

ALL-ALUMINUM *Room Cooler* EVAPORATORS and CONDENSERS

are Alodized

WITH "ALODINE"®

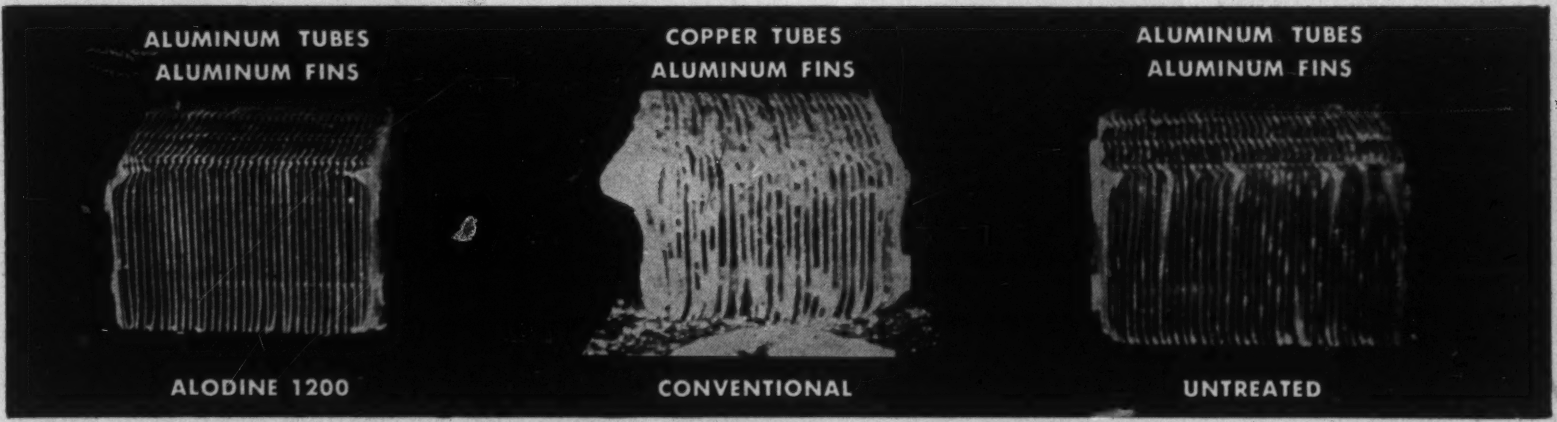
FOR EXTRA PROTECTION



Room cooler condensers and evaporators by Reynolds are light in weight, and of a unique design. The continuous aluminum tube eliminates many brazed joints, each a focal point for pit corrosion and leakage of refrigerant.

Fins are also of aluminum, thus eliminating galvanic action that leads to rapid corrosion and failure when dissimilar metals are in contact.

And finally, these durable all-aluminum assemblies are Alodized with "Alodine" to provide extra protection and adds years of efficient product life.



SALT SPRAY EXPOSURE = 1100 HOURS

Reynolds all-aluminum construction prevents the bi-metallic action that inevitably occurs when fins and tubing are made of dissimilar metals. In addition, the high corrosion resistance provided by Alodized aluminum coils gives Reynolds Room Cooler Evaporators and Condensers higher efficiency and longer life.

CHEMICALS
ACP
PROCESSES

Since 1914, Pioneering Research and Development in Metal Protection

AMERICAN CHEMICAL PAINT COMPANY

Ambler, Penna.

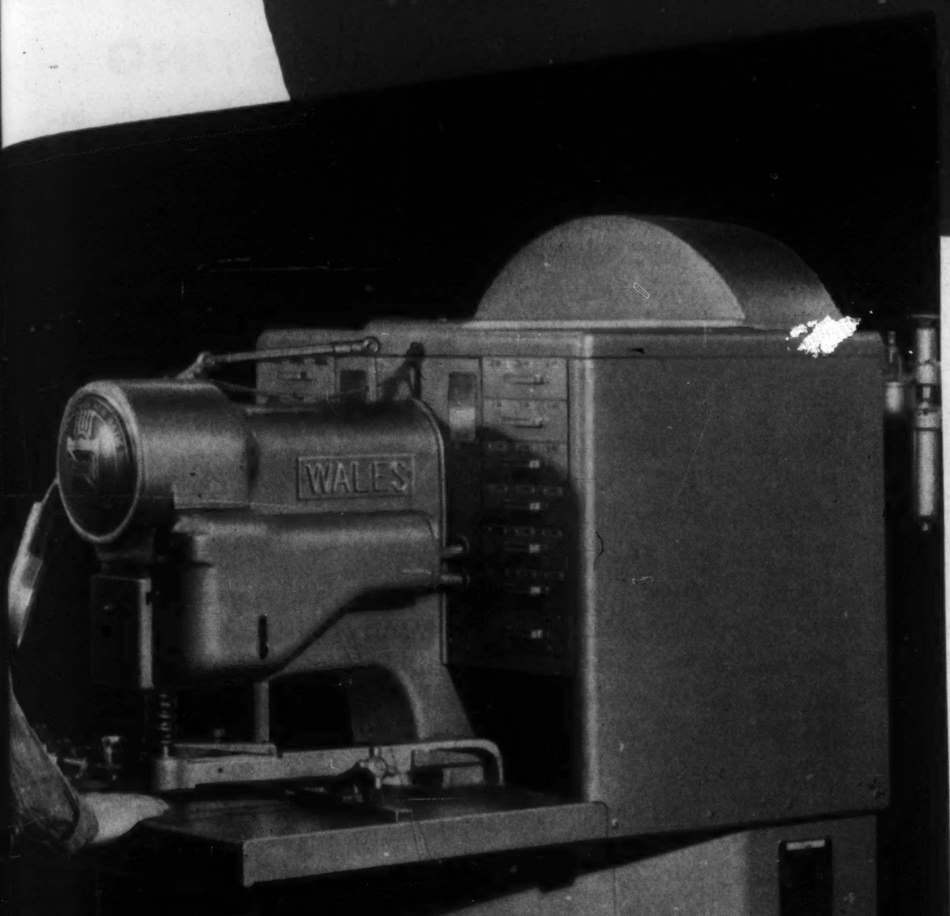
Detroit, Michigan *Niles, California* *Windsor, Ontario*

For more information, turn to Reader Service Card, Circle No. 409

For more information, Circle No. 410 ➤

HOW WALES Fabricators

produce FASTER *and* GREATER SAVINGS...

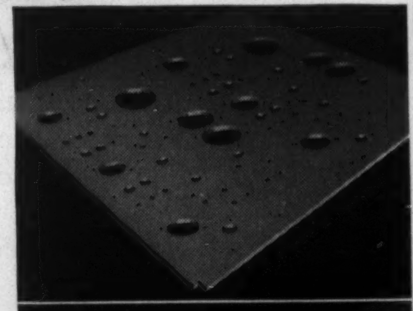


NO OTHER MACHINE LIKE IT!

Rapid interchangeability of punches and dies for various hole diameters plus faster notching and nibbling operations provide the typical astounding time studies described below.

How long would it take you to make similar parts?

Wales Fabricator, the only machine of its kind, permits working direct from blueprints or operation sheets . . . *no templates required.*

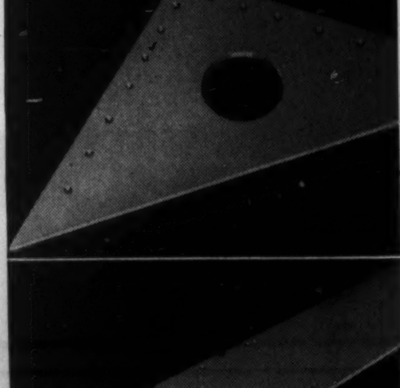


ELECTRONIC CHASSIS 12½" x 11½", with 118 holes and 4 notches was completed including setup in only 32.45 minutes and subsequent pieces in

6.44 minutes.

A part of FARM EQUIPMENT, 72½" x 22" with 32 holes and nibbled cut out was finished including setup in only 12.01 minutes, subsequent pieces in

2.32 minutes.



AN AIRCRAFT part 7½"x 4½" with 15 holes and 1 notch was produced including setup in only 3.52 minutes and subsequent pieces in only

54 seconds.

Part of an ELECTRIC REFRIGERATOR, 39⅞"x 8½" with 10 holes and 4 notches was fabricated including setup in only 5.61 minutes and subsequent pieces in only

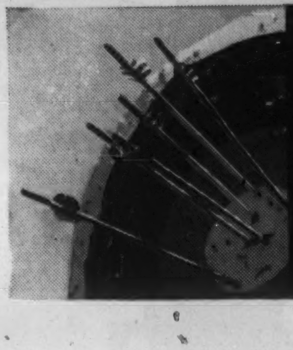
37 seconds.

It is too BIG a story to tell here so write today for the complete, fully-illustrated, functionally colored Wales Catalog 10-AA.

WALES-STRIPPIT CORPORATION

George F. Wales, Chairman
599 Payne Avenue, North Tonawanda, N. Y.
(Between Buffalo and Niagara Falls)
Wales-Strippit of Canada, Ltd., Hamilton, Ontario

Specialists in Punching and Notching Equipment



Advanced know-how makes the difference

Hitting the target is the result of know-how based on experience and experiment . . . of knowledge, imagination, skill and an intangible spirit that seeks perfection. Here are the highlights of casting methods which show how advanced know-how at Cooper Alloy has made it possible to produce intricate stainless steel parts to quality standards formely considered impossible.

SHELLCAST®

The production of cast shapes in thin, light weight, resin-bonded shells was born of the necessity to produce molds faster, more economically and with greater accuracy . . . and to cast parts to closer tolerances, with superior surface finish, greater legibility of markings and better appearance, as well as with thinner sections, small cored holes, well detailed contours, minimum draft and intricate recesses. These advantages are available to design engineers and manufacturers who specify—"Shell-cast by Cooper Alloy"—for their stainless steel components.

SHELLCORE

When the interior surface of the casting is as critical as the exterior, the core becomes a problem. The answer lies in the production of hollow "Shell" cores of superior accuracy and fine detail, which fit the mating molds much more closely than sand cores ever could. For extremes of tolerances—inside and out—Cooper Alloy *advanced know-how* with shell molds and shell cores makes the difference.

COREMOLD

Where specifications demand extreme smoothness of surface and close matching of many components, the use of special core mold assemblies becomes necessary. Core sand is used for making molds which provide excellent mating surfaces for cores and assure extra smoothness to the casting surface. Cooper Alloy *advanced know-how* puts coremold methods at your disposal.

CENTRIFUGAL CASTING

Casting centrifugally offers many specific advantages, including the ability to cast very thin, light weight airfoil sections. Whether made in metal molds or in sand, castings by the centrifugal method meet highest quality standards, particularly when backed up with Cooper Alloy *advanced know-how.*

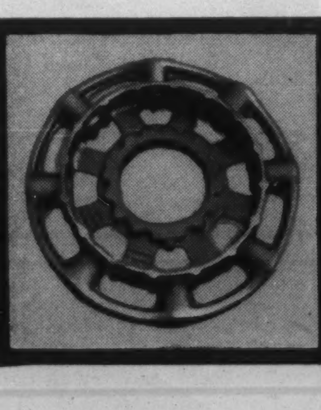
SAND CASTING

The heart of the foundry industry still lies with quality sand castings. But so important is the engineering, the patternmaking, the heading and gating, melting, molding, pouring, heat treatment, pickling . . . so critical is the use and application of x-ray, zyglo, gamma ray, pressure testing . . . so variable are the control items envolved in pouring thirty different high alloys . . . that even in the production of castings by "conventional methods" quality depends on experience. Here too, Cooper Alloy *advanced know-how* makes the difference.

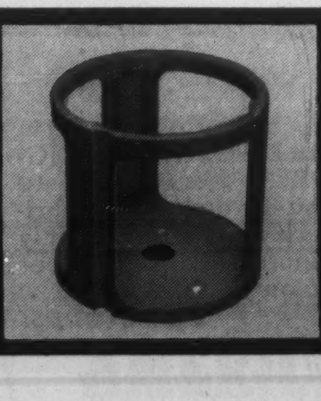
Tomorrow is ever with us . . .

Our search for better ways to produce quality stainless steel castings more economically . . . goes on continually. Research links us with tomorrow and assures you of the best in thinking, the best in technology. Cooper Alloy *advanced know-how* can make the big difference in your product. Your inquiries are invited.

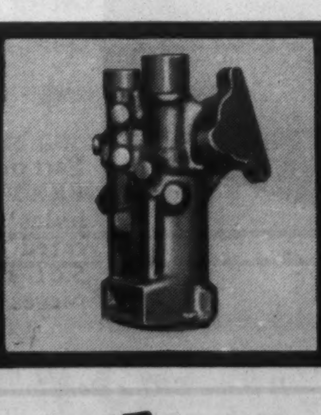
JET ENGINE SUPPORT
produced by Shellcast.®
Weight 35 lbs.



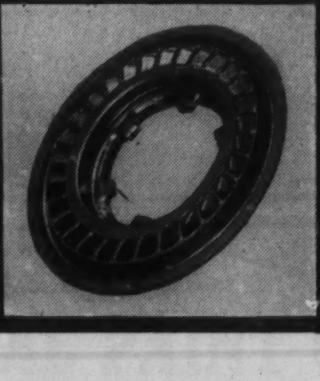
INSTRUMENT HOUSING
produced by combining Shellcast® and shellcore.
Weight 1 lb.



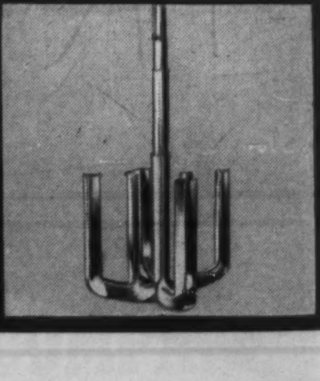
JET AFTERBURNER COMPONENT
produced by coremold.
Weight 11 lbs.



SUPERCHARGER DIAPHRAGM
produced by centrifugal casting using coremolds.
Weight 25 lbs.

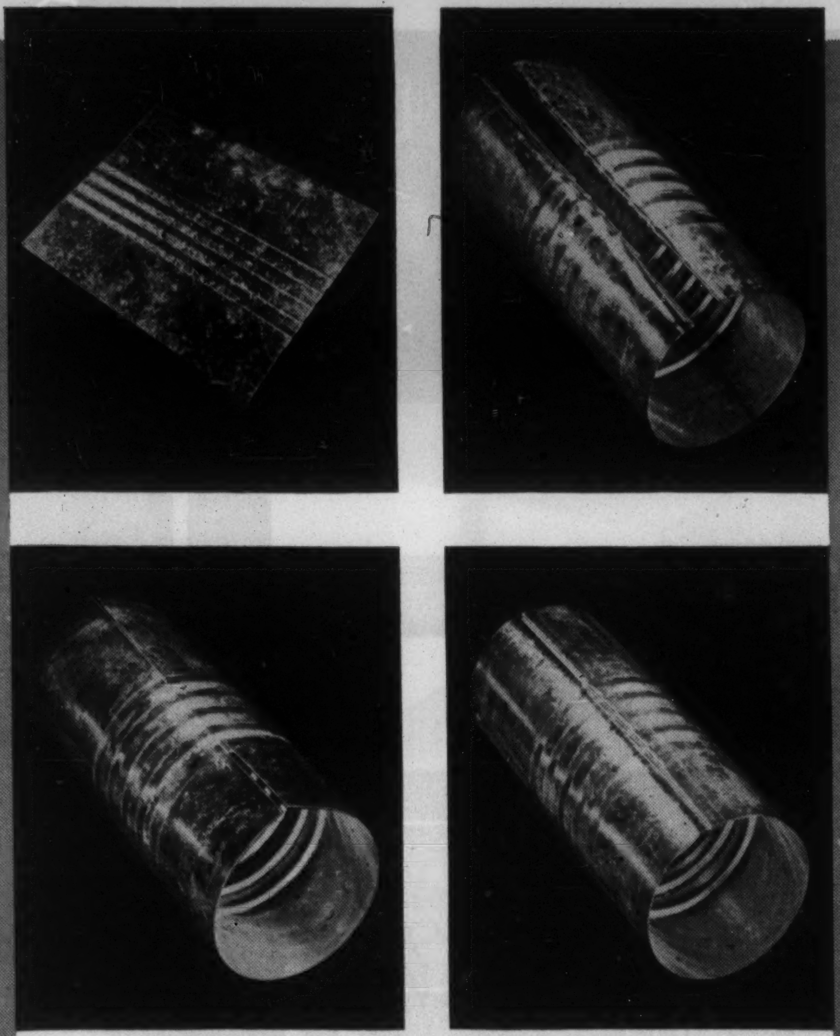


CHEMICAL AGITATOR
produced by sand casting.
Weight 2500 lbs.



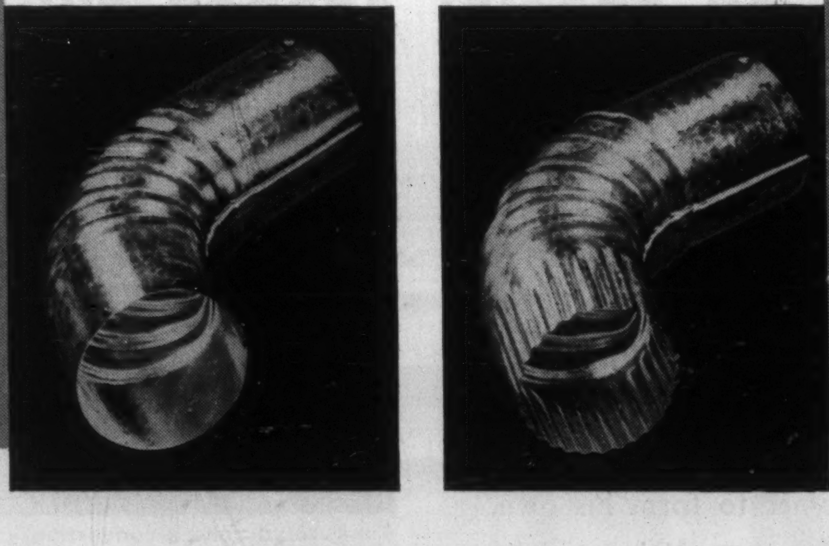
COOPER ALLOY
CORPORATION • HILLSIDE, N.J.
Foundry Products Division

For more information, turn to Reader Service Card, Circle No. 386



AN EXAMPLE: Previously made of terne plate and hand-dipped after fabrication, this finished conductor pipe elbow is now produced direct from flat, galvanized stock in six operations, *involving 180° interlocking bends, without coating failure.* This effects substantial savings in manufacture.

Photos courtesy of WHEELING STEEL CORP.



now!

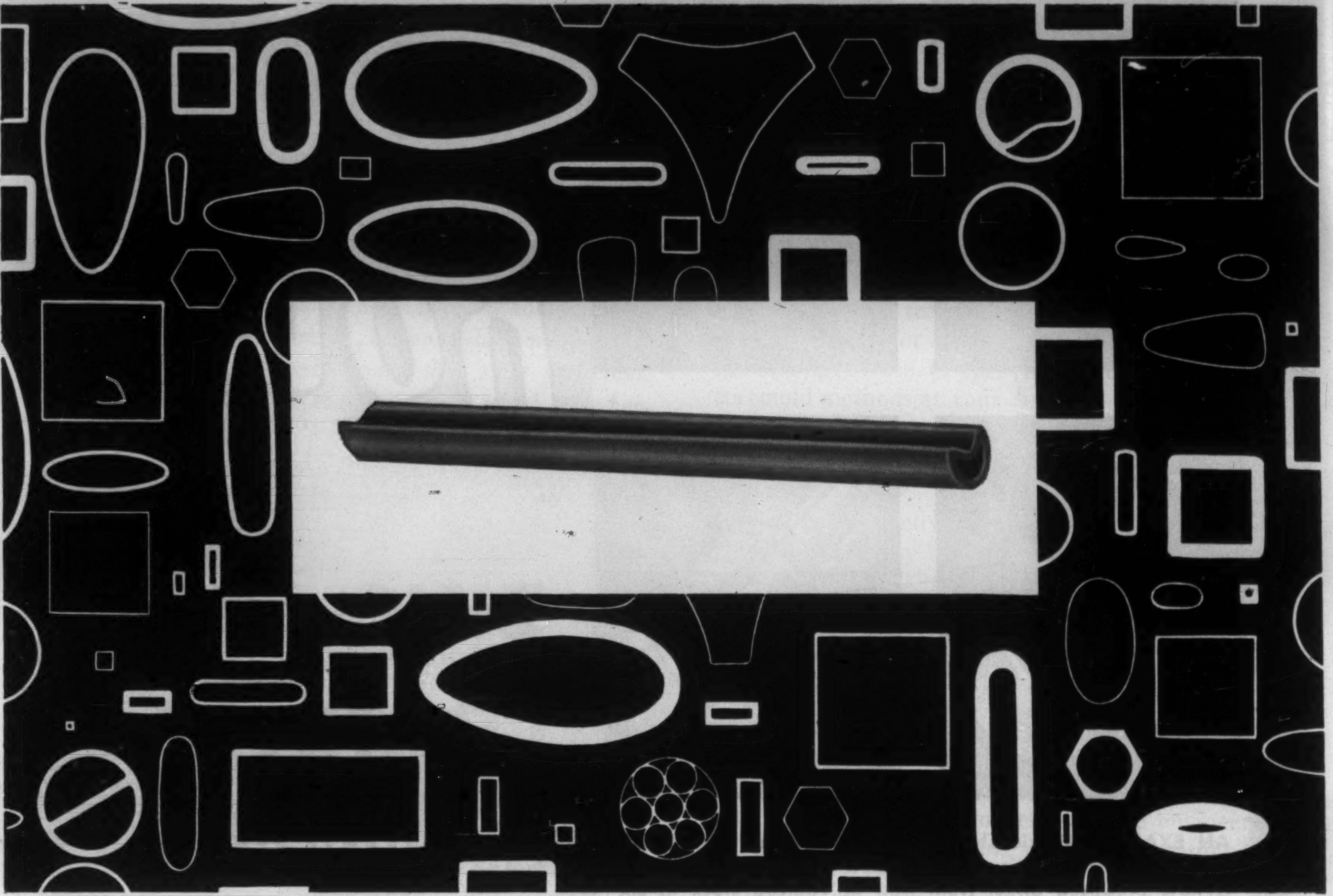
ZINC COATINGS as *ductile* as the STEEL BASE

Sheet metal users can now take full advantage of the superior qualities of zinc as a protective metal. Continuous line galvanizing — a major metallurgical achievement — makes possible the production of a soft ductile sheet steel with an incomparably tight zinc coating that will neither crack, peel or flake off even when subjected to the most severe forming operations. The combination of tight zinc coating and ductile steel base provided by the continuous line process, has not only improved the quality of galvanized steel, but has also greatly widened its field of application.

ST. JOSEPH LEAD COMPANY
250 PARK AVENUE, NEW YORK 17, N. Y.

HIGH GRADE
INTERMEDIATE
PRIME WESTERN

ST. JOE *electrothermic* ZINC



A few of the shapes available from SUPERIOR in standard specifications and tolerances or to your own design. The tube in the foreground is a gun drill shank made from 4130 alloy steel.

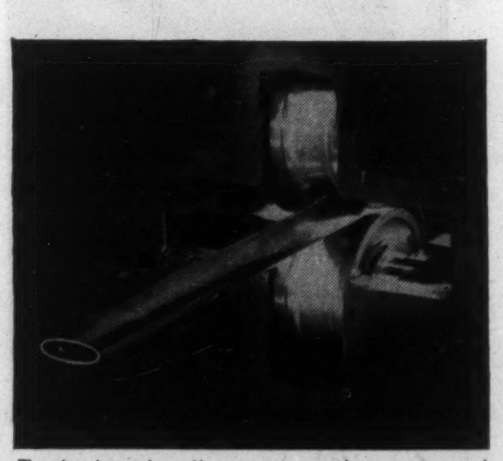
Save time and money on special shaped tubing

"SUPERIOR" TUBING IS IMMEDIATELY AVAILABLE IN A WIDE RANGE OF SHAPES, FORMS, ALLOYS

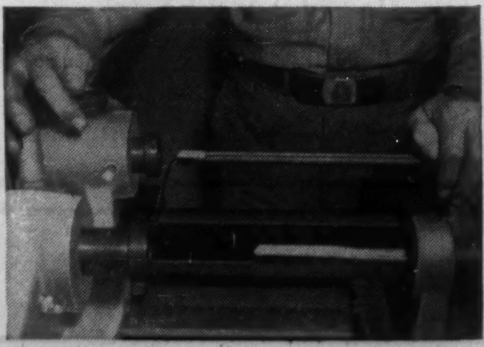
Many manufacturers have discovered that SUPERIOR's ability to supply as standard what many firms consider specialty tubing saves them trouble, time and money. SUPERIOR makes round, square, oval, rectangular, elliptical and flat oval tubing, for instance. It makes capillary tubing, pointer tubing, electronic tubing, telescopic sizes, large OD-light wall tubing. Over 55 analyses are available in carbon, alloy and stainless steels; in nickel and nickel alloys; in beryllium copper, titanium, zirconium.

The gun drill shank shown above and on the right is a good example of SUPERIOR's ability to supply unusual shapes. This newly rediscovered method of producing close-tolerance high-finish holes demands straight, rigid, accurate shanks with a 110° V-groove. SUPERIOR can produce such a shape—and others—in a fraction of the time and cost it would take a customer to form his own.

If you're having difficulty getting the kind of tubing you want, SUPERIOR can undoubtedly help you. Write for your free copy of Bulletin 40—*A Guide to the Selection and Application of Superior Tubing*. SUPERIOR TUBE COMPANY, 2006 Germantown Ave., Norristown, Pa. *On the West Coast:* Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif.



Turks-head rollers converting a round section of SUPERIOR tubing into the typical elliptical shape for a Bourdon gage tube.



Gun drills can produce holes from 4 to 230 diameters or more in 4 times the speed of conventional drilling methods or better. Holes so produced are straight and round to tolerances of 0.0002" or less and wall finishes are 7 mu-in or better.

All analyses available in .010" to ⅝" OD; certain analyses in light walls up to 2½" OD

Superior Tube

The big name in small tubing

For more information, turn to Reader Service Card, Circle No. 320

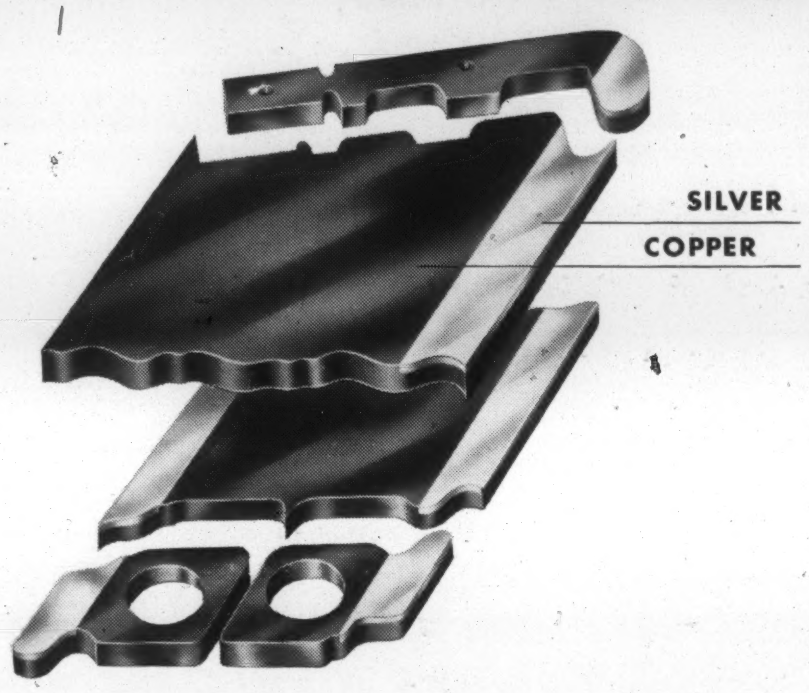
For more information, Circle No. 496 ➤

McLouth
STAINLESS
Steel

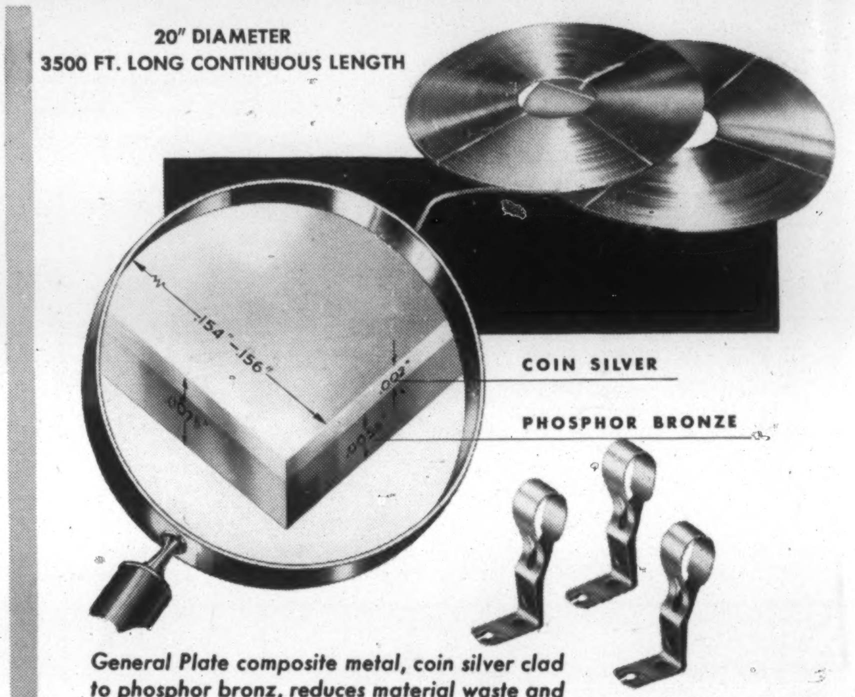
High quality stainless sheet and strip steel . . . for the product you make today and the product you plan for tomorrow.

McLOUTH STEEL CORPORATION
DETROIT, MICHIGAN
Manufacturers of Stainless and Carbon Steels

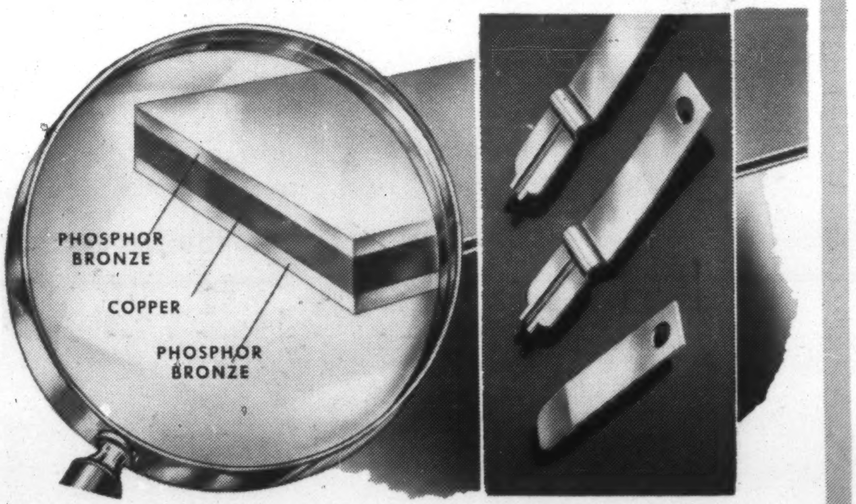
HERE'S HOW
GENERAL PLATE
COMPOSITE METALS
Cut Scrap, Increase Production, Reduce Costs and Provide Superior Performance



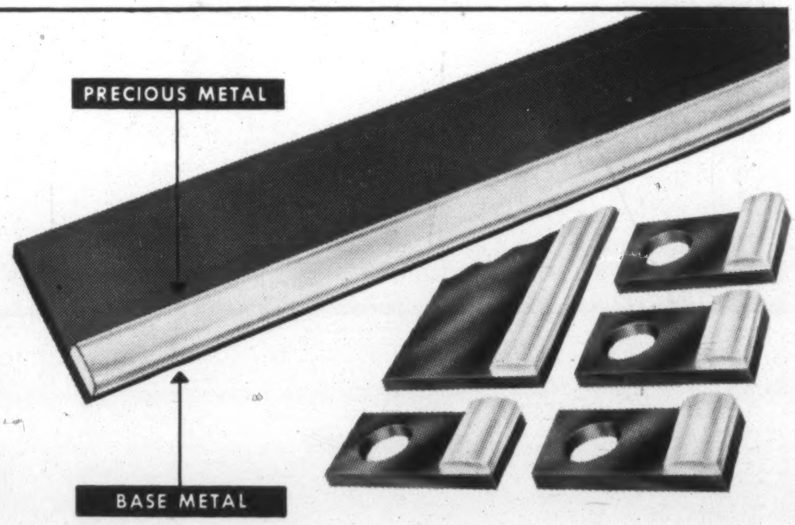
General Plate reduces fabrication and assembly costs of electrical switch contacts.



General Plate composite metal, coin silver clad to phosphor bronz, reduces material waste and manufacturing costs of electrical contact spring clips.



General Plate BRONCO provides higher electrical conductivity without increasing cross-sectional area of spring blades.*



General Plate TOP-LAY® provides quicker fabrication and longer wearing qualities in contact assemblies.

General Plate Composite Metals are improving performance and cutting costs for manufacturers of many types of products.

Made by metallurgically bonding one metal to another, they are available in sheet, strip, tubing or wire in various widths, thicknesses and diameters.

Composite base metals provide a new group of engineering material with properties not available in solid metals. Their use frequently results in lower production costs as compared to solid metals.

In many applications further economy results when General Plate supplies fabricated parts ready for assembly into your product. General Plate makes an infinite variety of fabricated parts, such as electrical contacts, collector rings and TRUFLEX® Thermostat Metal elements to customers' exact specifications.

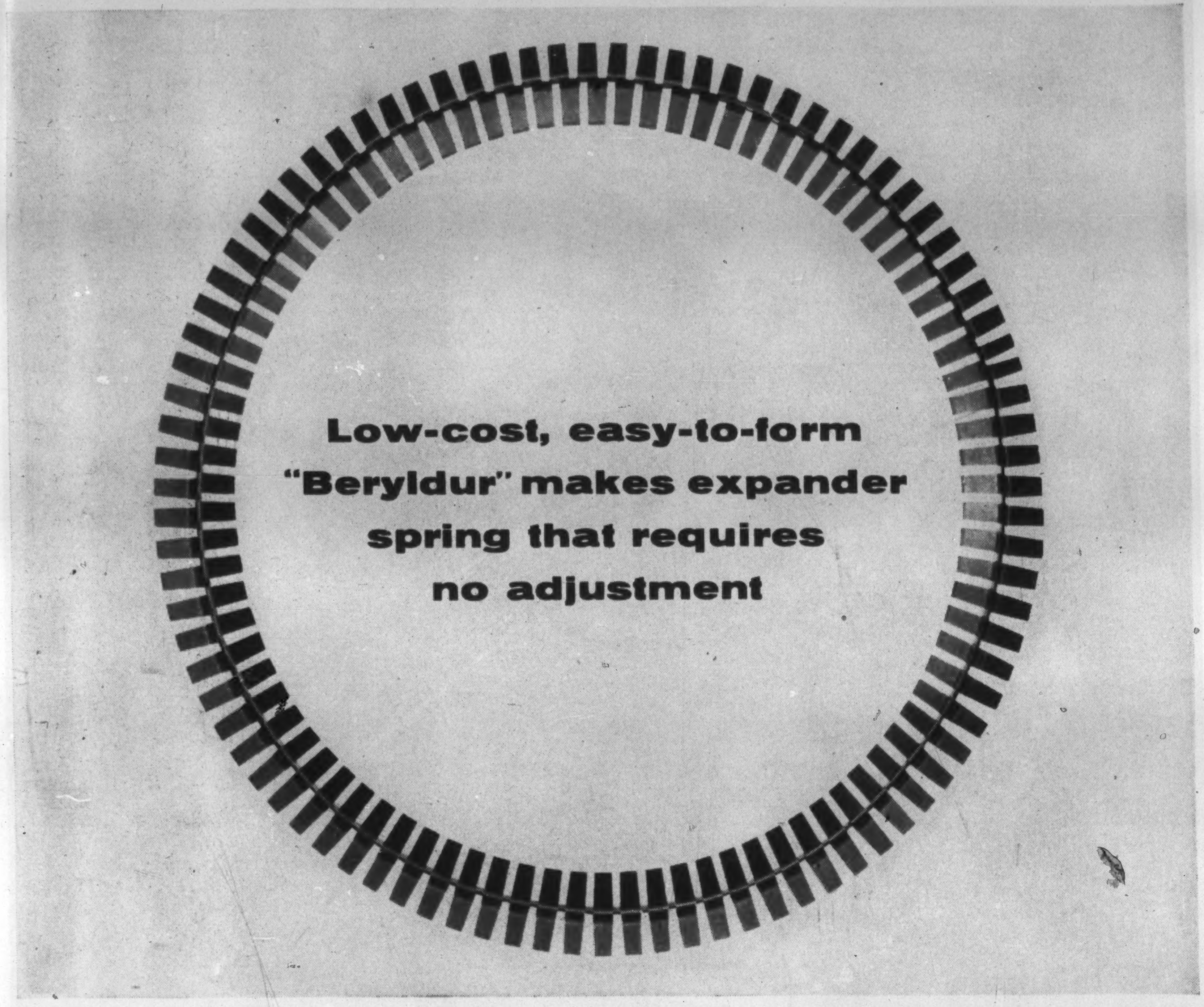
General Plate Engineers will gladly help you with your design details. Write for Catalog PR700.

*Trademark

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
66 FOREST STREET, ATTLEBORO, MASS.

For more information, turn to Reader Service Card, Circle No. 419

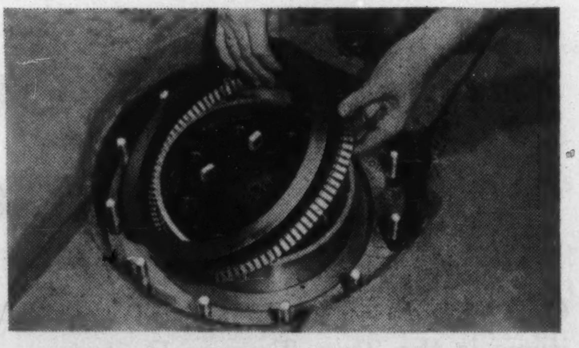


Low-cost, easy-to-form "Beryldur" makes expander spring that requires no adjustment

This finger spring is a U packing expander which maintains a seal at 0-5 pounds in the cylinder of a hoist.* What are the characteristics demanded in an application of this kind? First, corrosion resistance. "Beryldur," like all beryllium copper alloys, is highly corrosion resistant. Second, uniform spring pressure. If the expander is too loose, the packing will leak oil and water. If it is too tight, it will prevent the plunger from moving freely. It is enough to say on this point that this "Beryldur" expander never needs field adjustment.

Finally, formability is all-important. The 130° bends parallel to the rolling direction around a 1/16" radius could cause trouble—but in "Beryldur," grain direction is uniform and blanking is no problem. The expander was originally made of 12 6-in. sections riveted together; now it is made of two strips of mill-hardened "Beryldur."

The properties of "Beryldur" are midway between those of high-strength and high-conductivity "Berylco" Beryllium Copper alloys. "Beryldur" therefore has a higher tensile strength than brass or bronze, plus high fatigue strength, great resistance to wear, and good electrical conductivity. For sample material or engineering help, call or write any of the offices listed below.



"BERYLDUR" EXPANDER is pushed down over plunger, then U packing is forced over the expander.

Beryldur

A New Beryllium Copper Alloy

FURTHER INFORMATION about "Beryldur" is contained in this 4-page folder. Send for your free copy today.

BERYLCO®

Made by Globe Hoist Co., Des Moines, Iowa, Philadelphia, Pa.

THE BERYLLIUM CORPORATION

DEPT. 5F • READING 3, PENNA.

New York • Springfield, Mass. • Rochester, N.Y. • Philadelphia • Pittsburgh • Cleveland • Dayton • Detroit • Chicago • Minneapolis • Houston • San Francisco • Los Angeles

Representatives in principal world-trade centers

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TRUE TEMPER
ROCKET
PAT. PEND.
A16
TRUE TEMPER
ROCKET
INDESTRUCTIBLE

We helped make this hammer a smashing success

One of today's hottest hardware items is the True Temper Rocket, a new type of hammer that is guaranteed by the manufacturer to be indestructible in normal use.

In forging that hard-hitting head the True Temper people are using very substantial quantities of hot-rolled high-carbon bars of C-1078 steel supplied by Bethlehem. They put the forged head through a series of heat-treating operations that tempers the three critical zones—the striking face, the claws and the head—giving each one the exact combination of strength, hardness and toughness that it needs. Finally the entire head is polished to a lustrous finish.

These operations call for good, sound bar stock, the kind that so many prominent manufacturers, like True Temper Corporation, know they can count on from Bethlehem.

If your product requires hot-rolled carbon-steel bars, why not call on Bethlehem? Our carbon-steel bar products include standard sections, special sections and bar-size shapes. Also semi-finished carbon-steel products, including blooms, billets and slabs.

We suggest that you place your order with the Bethlehem sales office nearest you.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

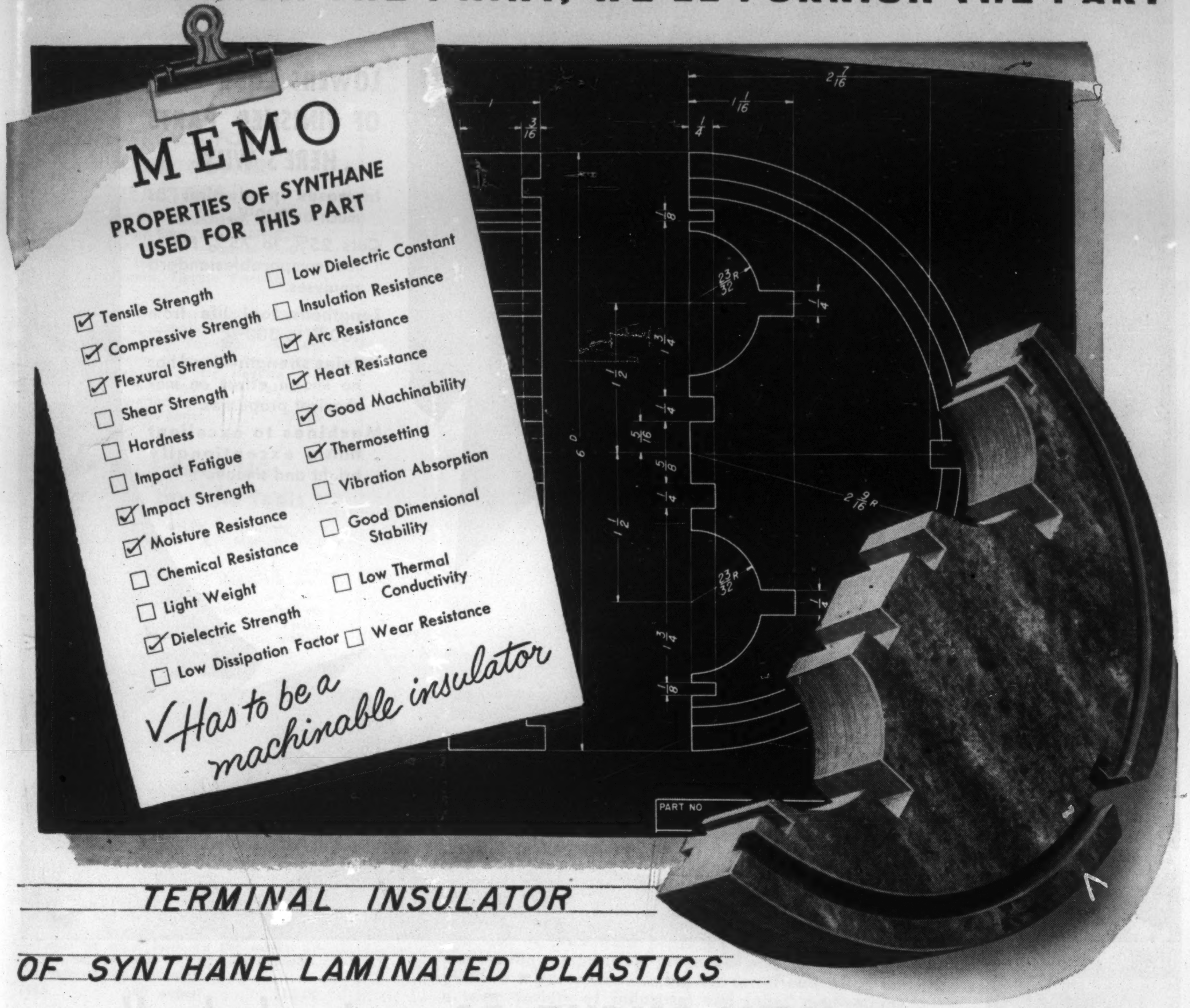
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

For more information, turn to Reader Service Card, Circle No. 424

YOU FURNISH THE PRINT, WE'LL FURNISH THE PART



MEMO

PROPERTIES OF SYNTHANE USED FOR THIS PART

- ☑ Tensile Strength
- ☑ Compressive Strength
- ☑ Flexural Strength
- ☐ Shear Strength
- ☐ Hardness
- ☐ Impact Fatigue
- ☑ Impact Strength
- ☑ Moisture Resistance
- ☐ Chemical Resistance
- ☐ Light Weight
- ☑ Dielectric Strength
- ☐ Low Dissipation Factor
- ☐ Low Dielectric Constant
- ☐ Insulation Resistance
- ☑ Arc Resistance
- ☑ Heat Resistance
- ☑ Good Machinability
- ☑ Thermosetting
- ☐ Vibration Absorption
- ☐ Good Dimensional Stability
- ☐ Low Thermal Conductivity
- ☐ Wear Resistance

✓Has to be a machinable insulator

TERMINAL INSULATOR OF SYNTHANE LAMINATED PLASTICS

RESISTS MOISTURE, HEAT, ARCING, BREAKAGE

Practically everything made requires a combination of several properties. And this terminal insulator is a shining example. It has to have high dielectric strength in a machinable insulator, good moisture resistance, excellent arc resistance, good heat resistance and mechanical strength. These and other requirements indicate *Synthane* laminated plastics for the job.

Starting with the blueprint, *Synthane* Corporation produces the needed base material with the right combination of properties, machines it with accuracy, and supplies the finished parts, with no waste, to the customer.

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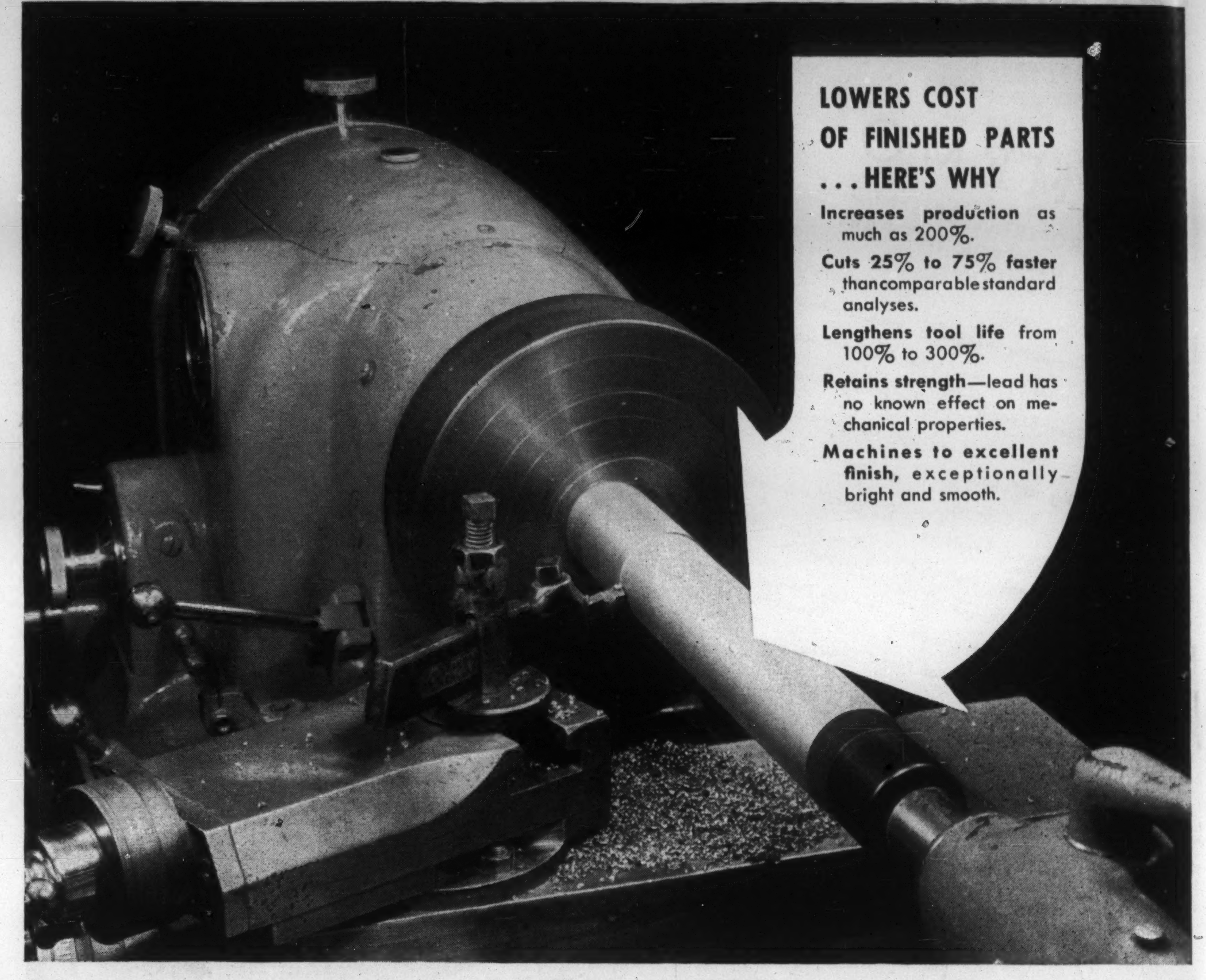

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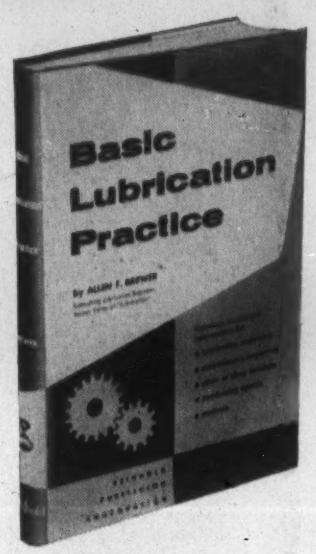

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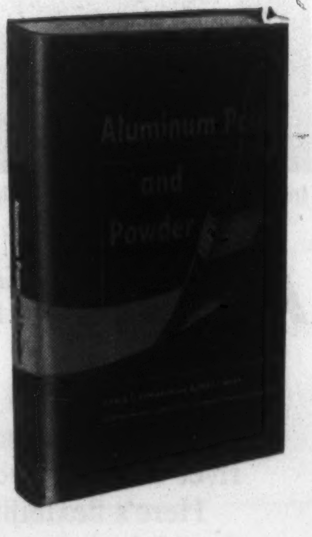

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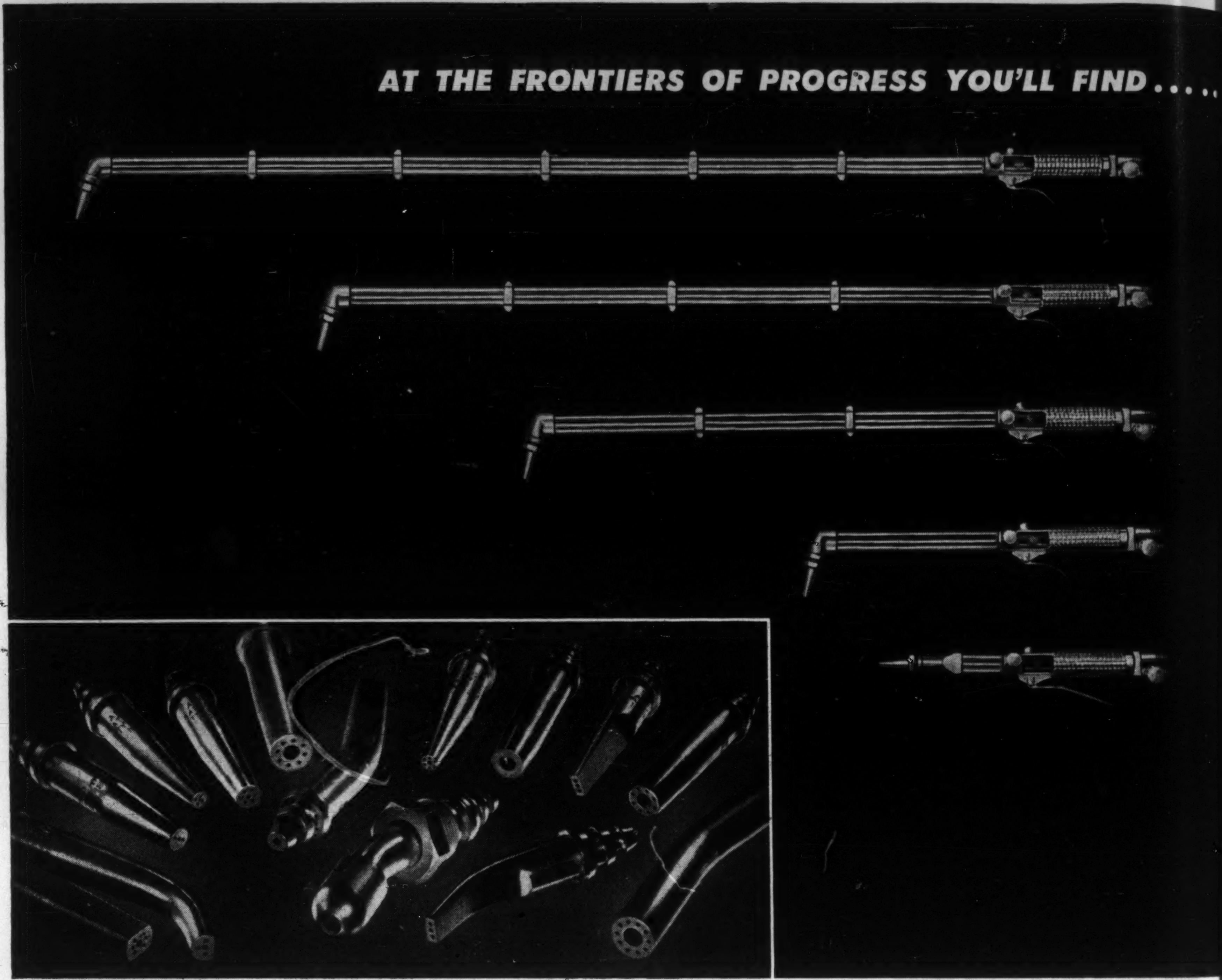

Inset: A few of the many Airco tips available for use with Airco torches.

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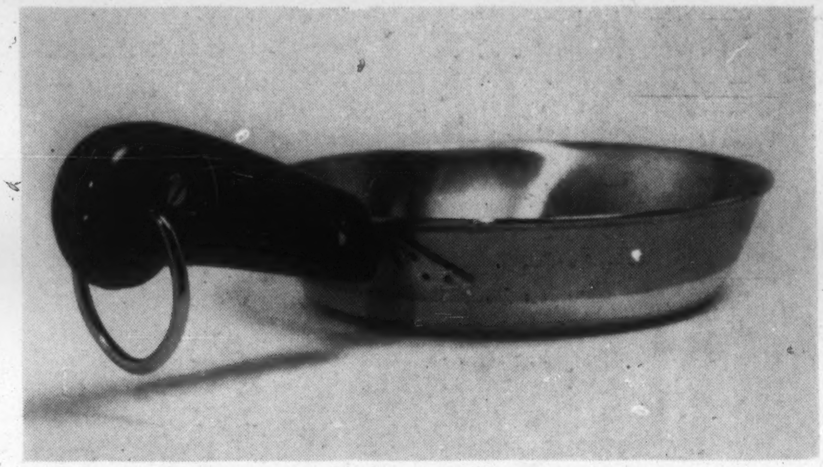
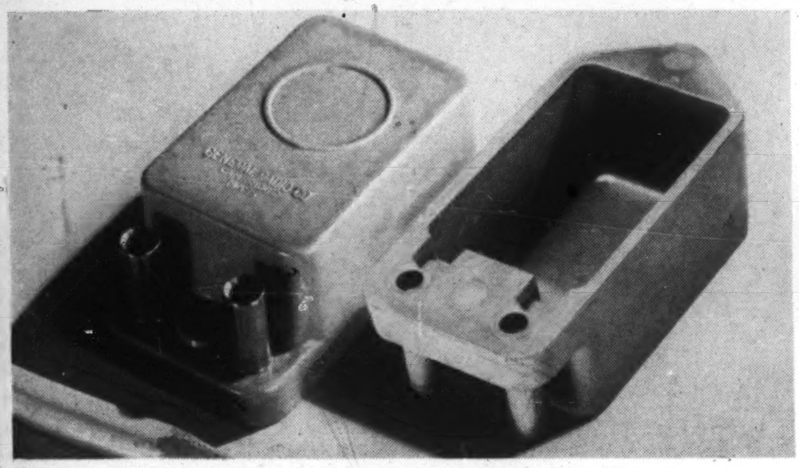
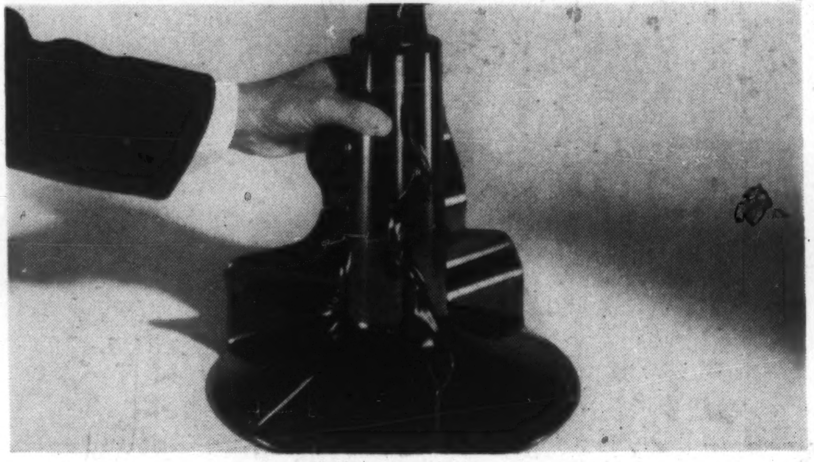
All-round serviceability is important in a telephone handset. So is good appearance. This one has both because it's molded of BAKELITE General-Purpose Phenolic BMG-5000 Black 25. Molding details are excellent, for example, in the case of the precisely formed inner sections that hold sensitive electrical components in place. The rich black color and smooth, glossy surface add strong eye-appeal. (Molded by Northern Industrial Chemical Co., Boston, Mass., for Stromberg-Carlson Co., Rochester, N. Y.)



Heat resistance is on a par with handsome design when it comes to handles for cooking utensils such as those molded from BAKELITE Heat-Resistant Phenolic BM-13335. This one is styled for good appearance. It gives a comfortable, safe, sure grip, won't get too hot to hold. The handle will withstand intermittent exposure to temperatures up to 500 deg. F. (Handle for Revere Ware molded by Diemolding Corp., Canastota, N. Y., and Norton Laboratories, Lockport, N. Y.)



Superior electrical insulation is provided by BAKELITE "Low Loss" Insulation Phenolic BM-17748. This material is more resistant to moisture and is more dimensionally stable than most phenolic molding materials. Used for this capacitor housing, it reduces dissipation factor and leakage conductance. Other applications for this material include coil forms, vacuum tube bases, and resistors. (Molded by Bay State Molding Co., Dorchester, Mass., for General Radio Co., Cambridge, Mass.)



Resistance to both impact and hot soapy water governs choice of a material for washing machine agitators. This one is molded in one piece from BAKELITE Water-Resistant Improved-Impact Phenolic BM-12315 Black. It withstands soaps, detergents, bleaches, and scalding water. The serpentine vanes are an unusual molding feature, but BM-12315 reproduced them with a glossy surface free of haze or flow marks. (Molded for the Whirlpool Corporation by the Modern Plastics Corp., Benton Harbor, Mich.)

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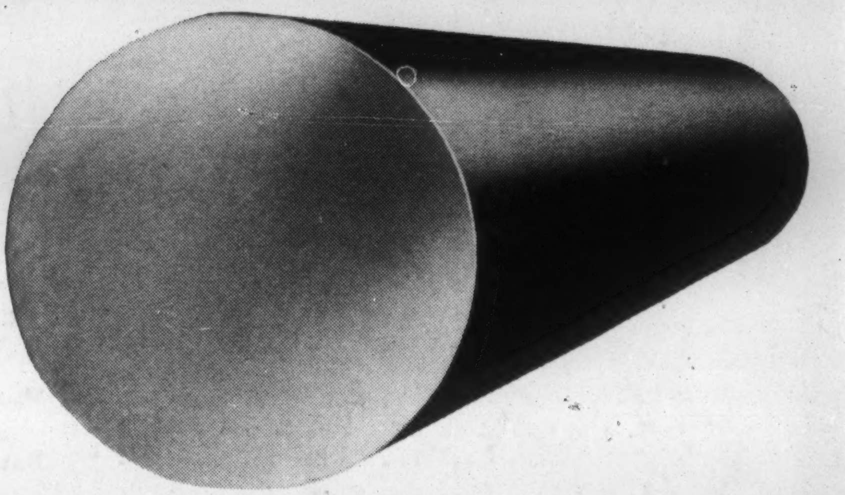
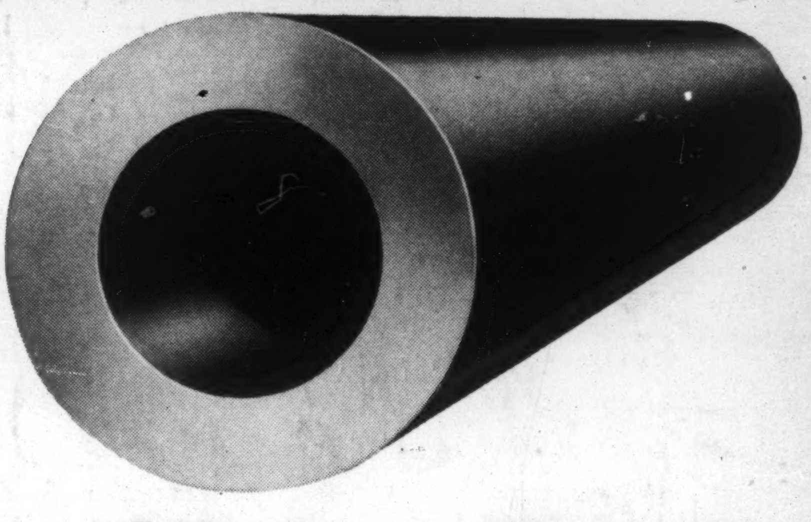
When you make hollow parts . . .

Why use bar stock?



start with seamless tubing



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